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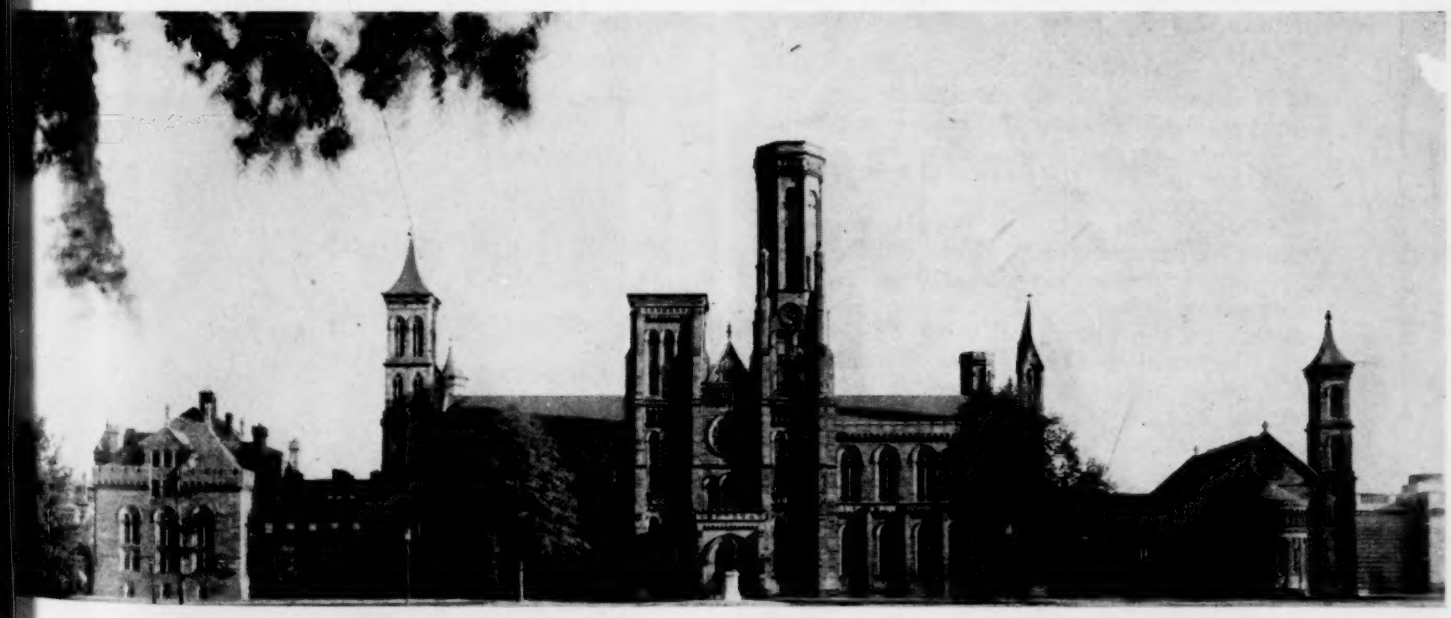
SCIENCE

Smithsonian Institution Centennial Issue

Alexander Wetmore

C. G. Abbot Frank H. H. Roberts, Jr.

Ray S. Bassler Frank A. Taylor Remington Kellogg



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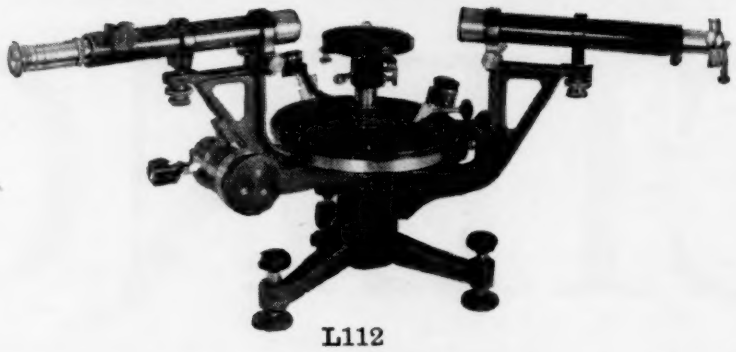

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Smithsonian Institution

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Humphry Davy was born in Penzance, Cornwall, 1778.

At 22 he published "Researches Chemical and Philosophical, chiefly concerning Nitrous Oxide or Dephlogisticated Nitrous Air and its Respiration." This book made his reputation.

He isolated the metals of the alkalies and alkaline earths and boron, demonstrated the elementary nature of chlorine and worked on the oxides of chlorine and on iodine; he also investigated the nature of flame and, as a result, invented a safety lamp for miners. His views on the intimate connection between electrical and chemical forces foreshadowed the modern atomic theory.

Davy was also a poet of ability; the poet Coleridge declared that if he "had not been the first chemist, he would have been the first poet of his age."

Davy died at Geneva in 1829.

This is the ninth of a series of brief biographies of eminent chemists sponsored by The Coleman & Bell Co., Manufacturing Chemists, Norwood, Ohio, U. S. A.

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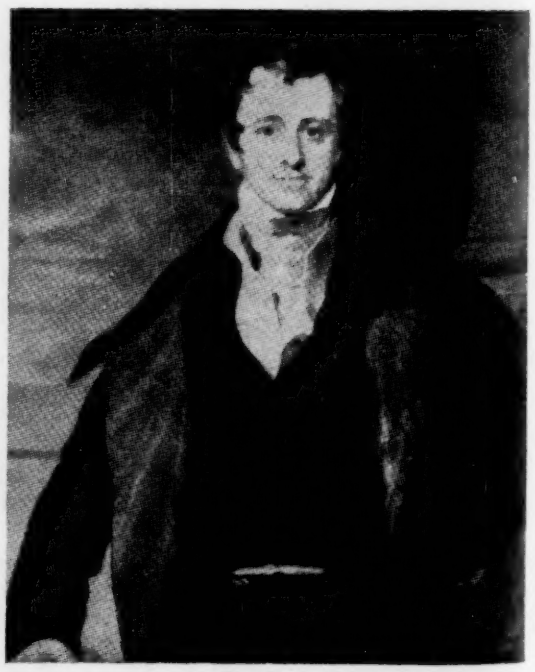

HUMPHRY DAVY
1778–1829

SCIENCE

Vol. 104, No. 2693 Friday, 9 August 1946

After One Hundred Years

Alexander Wetmore

Secretary, Smithsonian Institution

"NO IGNORANCE IS WITHOUT LOSS to man, no error without evil." Such was James Smithson's credo. He believed in this so strongly that he spent his life in painstaking scientific investigations to push back the boundaries of ignorance, and when death cut off his own efforts, he bequeathed his fortune to the United States of America "to found at Washington an establishment for the increase and diffusion of knowledge among men."

On 10 August 1846 the Smithsonian Institution came into being when James K. Polk, President of the United States, affixed his signature to the act of its foundation. For 100 years the Smithsonian has carried forward Smithson's ideal through scientific research in many fields, through world-wide exploration, through publications embodying the results of original investigation, and through other accepted methods of increasing and diffusing information.

At the middle of the last century Washington, the capital of our Nation, was a small city of some 50,000 inhabitants. Great expanses of unoccupied lands lay beyond the Appalachian Mountains, and the detailed exploration of the vast area beyond the Missouri River was under way. The American Philosophical Society met in Philadelphia, certain other societies with scientific interests had been organized, and small natural-history museums existed in a few centers such as Harvard College and Charleston. Science in any of its branches was at best an avocation in this new world, except to a few individuals, and those Americans who had opportunity or leisure for scientific studies looked almost wholly for guidance to the Old World, whence they or their immediate ancestors had come. Into such a setting came the new Smithsonian Institution, to support and encourage scientific and cultural knowledge and to give to American science a powerful and far-reaching stimulus.

Joseph Henry, first secretary of the Smithsonian, set up a wise and far-seeing plan of organization, effective in the sound basic principles on which it rested, embodying close cooperation with other agencies and individuals, and looking to the cumulative advancement of knowledge. After Henry came Spencer Fullerton Baird, biologist, as second secretary; then Samuel Pierpont Langley, astronomer and pioneer in aeronautical research; Charles Doolittle Walcott, geologist and paleontologist; and Charles Greeley Abbot, astrophysicist—all distinguished men of science. From its early activities, bureaus grew up around the parent Institution—first the U. S. National Museum, then the International Exchange Service, the Bureau of American Ethnology, the National Zoological Park, and the Astrophysical Observatory. As the public value of these services became evident, their support was assumed in whole or in part by the Government, although they remained as bureaus of the Smithsonian Institution.

In addition to its scientific activities the Smithsonian is charged in its act of foundation with responsibility for national art treasures. The art feature has culminated recently in the National Gallery of Art, given to the Nation by Andrew W. Mellon and augmented richly by other philanthropists. The

Throughout the last century the relationship between the Smithsonian Institution and the American Association for the Advancement of Science has been a close one. From time to time members of the Institution staff have been officers of the Association and its affiliated societies, and its members have been active on Association committees.

For the last 40 years the official mailing address of the Association has been the Smithsonian Institution Building, Washington, D. C., where the Institution has managed to provide office space although space for its own manifold activities is at a premium.

In presenting this special issue of *Science*, under the guest-editorship of Paul H. Oehser, Assistant Chief, Editorial Division, Smithsonian Institution, commemorating the Centennial of the Smithsonian Institution, the AAAS, in only a small way, recognizes an accumulating debt.

Gallery is established as a bureau of the Smithsonian Institution, but is directed by a separate Board of Trustees. The earlier art interests of the Institution are included in the National Collection of Fine Arts and the Freer Gallery of Art. The latter, presented and endowed by Charles L. Freer, is devoted chiefly to the Oriental field, and through its highly valuable archeological materials will figure more and more importantly in strictly scientific studies.

From one building, a small staff, and a single publication, the Institution has grown in a century until it now occupies five buildings on the Mall and numerous structures at the National Zoological Park, while it issues 14 series of publications, each devoted to a particular sphere.

The main influence of the Institution has centered in its scientific staff, its series of publications, and its collections. The first comprise the heart of the organization, which continues through the younger members who come, as older ones drop out, to carry forward the living Institution in its policies for the advancement of science. The publications of the Institution constitute one record of its accomplishment in the fields of scientific culture. The collections are the base for much research and investigation and in addition are a scientific and cultural archive that the Institution guards on behalf of our Nation.

The various phases of the Institution's scientific work are passed in factual review in papers that follow, the whole comprising an outline of the major activities as they have developed and operated during its first 100 years. From this foundation the Smithsonian Institution looks forward in 1946 toward the second century of its work.

Astrophysical Contributions of the Smithsonian Institution

C. G. Abbot

Research Associate, Smithsonian Institution

ASTROPHYSICS AND THE SMITHSONIAN Institution were born about the same time. Joseph Fraunhofer, to be sure, had discovered many absorption lines in the sun's spectrum in 1814–15, but G. R. Kirchhoff and R. Bunsen's key to the interpretation of these did not come until about 1860. Photography was used to observe the shorter-wave solar spectrum by Rutherford, Mascart, Draper, and others during the first quarter century of the Smithsonian. But it was not until H. A. Rowland constructed his gratings, and photographed through the range of ultraviolet and visible about 1890, that anything like an adequate observation of the solar spectrum was made. Even Rowland perforce neglected the far-reaching region of the infrared, first mapped in detail at the Smithsonian and not available to photography until recent time. Of the numbers, distances, diameters, masses, temperatures, and detailed composition of the stars very little was known until the present century came, with its great telescopes and their exact driving mechanism, improved photography, knowledge of the structure of the atom, and far-reaching theoretical advances in physics.

As to our own habitation, the earth, it was not until many years after the establishment of the Smithsonian Institution that extensive observations of the weather were undertaken by governments. Weather studies have been a major feature in Smithsonian researches from its beginning. The Institution has also contributed its part to our present knowledge of the sun and stars.

Smithsonian promotion of astrophysics has been of two kinds. Much research has been done by members of its own staff. In addition, many choice researches by able men have been financed in part or whole, or published, with Smithsonian funds. In this brief survey it will not be possible to mention all these grants-in-aid, but their importance may be indicated by a few examples.

As we now believe, the sun's energy depends on a catalytic transformation of hydrogen into helium whereby a certain amount of mass is lost. Our knowledge of this loss depends on the exact determination of the relative atomic weights of hydrogen and oxygen by E. W. Morley, with the aid of a superlatively fine balance supplied to him by the Institution. His research was published in 1903 in *Smithsonian Contributions to Knowledge* (Vol. 29). In the same volume is the report of A. A. Michelson's epoch-making research, "On the application of interference methods to spectroscopy," promoted by Smithsonian grants. There appears also a report by V. Schumann "On the absorption and emission of air and its ingredients for light of wave lengths from 250 to 100 μμ." This work, supported by Smithsonian grants, opened up a new region of the spectrum called for some time "the Schumann region." Crowning this extraordinary volume is the paper of Lord Rayleigh and Sir William Ramsay, "Argon, a new constituent of the atmosphere," for which the Institution awarded them the Hodgkins grand prize of $10,000.

The *Contributions* of 1907 (Vol. 34) contains a re-

print of Draper's classic, "On the construction of a silvered glass telescope," published in 1864 (Vol. 14). With it is published G. W. Ritchey's even more valuable article, "On the modern reflecting telescope and the making and testing of optical mirrors."

In this partial reference to valuable contributions to astrophysics on the part of outsiders who have received the Institution's aid I can go no farther than merely to cite the following references to *Smithsonian Miscellaneous Collections*:

A. Ångström: "A study of the radiation of the atmosphere," 1915–16, Vol. 65, No. 3.

H. H. Clayton: Many papers on the sun's influence on weather—1917–18, Vol. 68, No. 3; 1919–20, Vol. 71, No. 3; 1924–26, Vol. 77, No. 6; 1926–27, Vol. 78, No. 4; 1933–34, Vol. 82, No. 15; 1933–34, Vol. 89, No. 15; 1939, Vol. 98, No. 2; 1940, Vol. 99, No. 5; 1946, Vol. 104, No. 19.

R. H. Goddard: "A method of reaching extreme altitudes," 1919–20, Vol. 71, No. 2; and "Liquid propellant rocket development," 1936, Vol. 95, No. 3.

Clayton edited and extensively aided the preparation of "World weather records," 1927, Vol. 79, and 1934, Vol. 90. A third volume is now in press, bringing this invaluable source material up to the epoch of 1940.

It was the Institution's belief that Goddard's classic researches would open the way to determining the constitution of the upper atmosphere and enable the obtaining of photographic spectra of the extreme ultraviolet regions for the sun and the brighter stars. In view of the recent great development of rockets, this hope seems likely to be realized.

I turn now to researches by the Institution through members of its staff. As the sun is the fountain of life, maintainer of temperature, ultimate source of power from coal, oil, and water, and the fundamental cause of climates and weather on the earth, besides being the most available subject for stellar research, it is natural that the Institution's astrophysical investigations should center on the sun in these various relationships.

The first secretary, Joseph Henry, actively promoted weather studies throughout his life. He was particularly concerned with collecting long-range data on the climates and weather of stations in every region, as a basis for sound meteorological advance. He also recognized immediately the usefulness of the then new telegraph to promote forecasts of day-to-day changes in weather. He persuaded the regents of the Institution to sanction the use of a considerable part of its revenue to obtain weather reports from a great network of voluntary observers. Instruments were prepared, directions for observation given, telegraph companies employed, and for about 20 years the Smithsonian was, indeed, the national weather bureau. Cleveland Abbe wrote in 1871:

> However frequently the idea may have been suggested of utilizing . . . the electric telegraph, it is to Professor Henry and his assistants in the Smithsonian Institution that the credit is due of having first actually realized this suggestion. . . . The Smithsonian Institution *first in the world organized* a comprehensive system of telegraphic meteorology.

When the Institution turned over its great system of meteorological reports to the Signal Corps in 1870, Secretary Henry summed it up as follows:

> The Smithsonian meteorological system was commenced in 1849, and has continued in operation until the present time. . . . It has done good service to the cause of meteorology: 1, in inaugurating the system which has been in operation upward of twenty years; 2, in the introduction of improved instruments after discussion and experiments; 3, in preparing and publishing at its expense an extensive series of meteorological tables; 4, in reducing and discussing the meteorological material which could be obtained from all the records from the first settlement of the country till within a few years; 5, in being the first to show the practicability of telegraphic weather signals; 6, in publishing records and discussions made at its own expense, of the Arctic expeditions of Kane, Hayes, and McClintock; 7, in discussing and publishing a number of series of special records embracing periods of from twenty to fifty years in different sections of the United States, of great interest in determining secular changes of climate; 8, in the publication of a series of memoirs on various meteorological phenomena, embracing observations and discussions of storms, tornados, meteors, auroras, etc.; 9, in a diffusion of a knowledge of meteorology through its extensive unpublished correspondence and its printed circulars.

The third secretary, Langley, long an ardent observer of solar phenomena, created the Astrophysical Observatory as a branch of the Institution about 1890. Its first contribution was the bolographic scanning of the infrared solar spectrum to map the lines and bands of absorption there, beyond the reach of Rowland's photography. These lines and bands are caused by the gases of the sun's and earth's atmospheres. In doing this, the hairlike bolometer, which had been an untamed instrument, became easier to use than a mercury thermometer, though capable of measuring temperature differences of less than a millionth of a degree. The research, published about 1900 as Vol. 1 of *Annals of the Astrophysical Observatory,* showed the distribution of intensities in the solar spectrum from 0.76 to 5.3 microns of wave length. It disclosed 740 lines and bands of absorption in this region and indicated their relative intensities. It included a precise determination of the dispersion of rock salt and

of fluorite, materials much used for infrared spectroscopy.

In 1928 C. G. Abbot and H. B. Freeman, at the request of H. D. Babcock, repeated this bolometric search for absorption lines in the infrared solar spectrum. They had the advantages of Mount Wilson cloudlessness, long bolometric experience, greater sensitivity of apparatus, and wider spectral dispersion. They reported on over 1,200 lines and bands of absorption within the wave length range 0.76–1.82 microns. Babcock assures me that, so far as photography yet extends in this region, he finds practically every indentation in their bolographic curves meaningful, and the research indeed enables confirmations of theoretical conclusions regarding regularities of atomic and molecular spectra.

In 1902, under Langley's direction, C. G. Abbot and F. E. Fowle began researches on the transmission of the earth's atmosphere for different wave lengths, the intensities in the solar spectrum at the earth's surface and outside the atmosphere, and the problem: Is the sun a variable star, and, if so, what effects do its variations cause in weather? At that time the textbook values given for the solar constant of radiation (average heat equivalent per unit area of solar radiation at mean solar distance) ranged from 1.76 to 4.0 calories per centimeter square per minute. The only fairly accurate instrument for measuring total solar radiation was the Ångström electrical compensation pyrheliometer, then subject to errors of several per cent, since corrected.

The research has gone on until the present time. Its principal results are as follows:

(1) The solar constant of radiation lies certainly within 1 per cent of 1.94 calories per centimeter square per minute. Spectrobolometric determinations of it were checked by sounding balloon observations at an altitude of 15 miles. (2) The sun, as a variable star, is subject to changes of output, never as yet observed to exceed 5 per cent and generally less than 1 per cent. (3) The sun's variations may be classed in two types: (a) day-to-day changes, usually running between high and low in three to five days, repeating at the average rate of four rising, four falling, per month, and found to be associated with the 27-day rotation of the sun and with the waxing and waning of prevalence of faculae and flocculi; (b) long-interval solar radiation changes of periodic nature, such that 16 such cyclic changes go on simultaneously, with periods ranging from 7 to 273 months, all being nearly integral submultiples of 273 months, or two sunspot cycles. (4) Both day-to-day and long periodic solar changes are major factors in the control of weather. (5) The atmospheric transmission for radiation has been measured at over 40 wave lengths between 0.34 and 2.3 microns at many stations ranging from sea level to 14,500 feet altitude, at all seasons of the year, and in a great variety of atmospheric conditions. (6) The amount of radiation scattered by sky and clouds has been measured under similarly wide diversity of conditions. (7) The distribution of radiation over the sun's disk, a matter of much interest in the theory of the star, was determined for many wave lengths. Indications were found of its slight variability associated with changes of the solar constant. (8) The temperature of the sun was estimated in three ways, twice from the form of distribution curve of radiation in the spectrum and again by the value of the solar constant. The average result is about 6,000° Absolute Centigrade. (9) The energy spectrum curve of solar radiation was determined between wave lengths 0.34 and 2.35 microns. (10) The change of form of the energy spectrum curve attending solar variation was determined and found to be rapidly increasing toward short wave lengths for increasing values of the solar constant. (11) Solar energy was harnessed for power, distilling, and cooking. An efficiency of power production exceeding 20 per cent is obtained. (12) F. E. Fowle made a classic study of the transmission of long wave radiation through long columns of air containing known loads of water vapor and carbon dioxide. (13) Fowle also determined ozone in the atmosphere and computed with high accuracy the number of molecules per cubic centimeter of air from measures of atmospheric transmission. His long editorship of the Smithsonian Physical Tables was highly valuable. (14) L. B. Aldrich, in cooperation with the Signal Corps, made the classic measurement of the reflecting power, or albedo, of an infinitely extending cloud surface. He found it to be 78 per cent. (15) Radiometric determinations were made with the 100-inch telescope at Mount Wilson, California of the distribution of radiation in the spectra of the bright stars and planets. (16) Standard instruments for measuring sun and sky radiation were devised, used, and furnished abroad to fix the scale of measurement of solar radiation in heat units. Foreign measures are usually expressed as on "the Smithsonian scale."

These are the principal items, but they by no means exhaust the results described in Vols. 1–6 of *Annals of the Astrophysical Observatory* and in the many papers of members of the staff, published for the most part in *Smithsonian Miscellaneous Collections* and the *Astrophysical Journal*.

Many expeditions have been made. Total solar eclipses were observed in 1900, 1901, 1908, 1918, and 1919. Bolometric measures of the brightness of the corona and pyranometric measures of the brightness of the sky were the most interesting results of these observations, although they also included photographic

Objections having been raised by some as to the soundness of our measures of atmospheric transmission, simultaneous measures of the solar constant of radiation were made in 1910 at Mount Wilson, California (5,700 feet) and at Mount Whitney, California (14,500 feet). Again in 1911 and 1912 solar constant measures were made simultaneously at Mount Wilson and at Bassour, Algeria. Since 1918, simi

taneous measures have been made on thousands of days by stations in the Northern and Southern Hemispheres. No differences above the small experimental errors have ever been found between the solar constant results obtained under these diverse conditions of atmospheric transmission. In all, as many as 12 different stations have been occupied by us for solar constant work. These have been located in North and South America, Africa, and Asia and range from sea level to 14,500 feet in elevation. Several of them have been continuously occupied in desert regions for 20 years or more.

During World War I C. G. Abbot and L. B. Aldrich were active in the improvement of searchlights. The Corps of Engineers report on that activity even gave the leading place to our efforts. In World War II studies were made of the relations of radiation to clothing and on a filter to exclude visible light and infrared rays while admitting the ultraviolet. Both researches were successful.

Since the end of the war the Observatory, now under the direction of L. B. Aldrich, has been amassing great quantities of data for the Army on the intensity of sun and sky radiation at the earth's surface at all times of the day and year.

For many years the writer had been keenly interested to know which of the sun's rays were most effective in supporting plant growth, through the assimilation of carbon dioxide from the air. About 1930 the Division of Radiation and Organisms was established under grants from the Research Corporation of New York. W. H. Hoover did there a fine piece of research which fixed the relative efficiencies of different wave lengths to promote photosynthesis in wheat. He used with close agreement three different sources of radiation: the Mazda lamp, the carbon arc, and sunlight. The curve of wave length and photosynthesis showed two maxima in the blue and the red, respectively, where chlorophyll has absorption bands. Rays of wave lengths less than 4,000 A. or more than 7,500 A. appear to be totally ineffective in photosynthesis. Many other interesting researches which relate to different aspects of radiation and plant growth have been carried on in the Division. Most of these have been published in *Smithsonian Miscellaneous Collections*.[1]

Congress has supported the Astrophysical Observatory financially in part and has authorized the inclusion in it of the Division of Radiation and Organisms. A considerable part of the financial support has, however, come from private sources, including the Hodgkins Fund and the Arthur Fund of the Smithsonian endowment and gifts from John A. Roebling aggregating over $500,000 during the past 26 years. Mr. Roebling is well versed in science and ardently interested in the problems of the dependence of climate and weather on solar radiation. He makes no blanket appropriations but discusses with great acumen each individual project. Without his aid and wise suggestions we should have come far short of our present accomplishment.

[1] See papers by Johnston, McAlister, Weintraub, Meier, and others.

One Hundred Years of Smithsonian Anthropology

Frank H. H. Roberts, Jr.
Assistant Chief, Bureau of American Ethnology

FROM ITS VERY INCEPTION the Smithsonian Institution has been a leading participant in the field of anthropology, particularly in the study of the New World aborigines. Throughout the 100 years of its history, this phase of its operations has been one of its better-known and more generally popular activities. However, the word anthropology does not appear in the heading summarizing such work until the Annual Report for 1877. Previously, and reflecting American concept in general, most of the branches at present incorporated under Anthropology were grouped under Ethnology. In the rare cases where the word was used it was, for the most part, in the restricted sense of the study of physical man. The change was brought about by influences spreading from Europe, where, during the 1860's under the stimulus of the appearance of Darwin's *Origin of species* and the determination of the geologic antiquity of man, the subject had a rapid growth. Many societies and museums devoted to the "whole science of man" were organized, and there was an accompanying, although somewhat delayed (because of wartime conditions in the United States), increase of interest in the American field. It was two decades or more, however, before thinking in the Institution and the country at large changed from ethnology, archeology, and Indian linguistics to the more comprehensive anthropology.

In line with Joseph Henry's policy of not recruiting men for original research and supporting them and their work entirely from the funds of the establishment, it was many years before an anthropological staff was organized. When such steps were taken, the necessary funds were furnished by the Government.

For almost 30 years the Institution's activities in this field consisted of arousing public interest and obtaining voluntary assistance in the solution of special problems, providing means of publication for the monographs and reports prepared by others, granting modest funds or other assistance to further the work of recognized scholars, and cooperating with other institutions and scientific societies in promoting various kinds of researches. As a matter of fact, these activities are still carried on and, in conjunction with the now established and widely known original investigations by staff members, form an important part of the Institution's program. From the beginning to the present, cooperation has been an important factor in anthropological work.

One of the first acts of the newly founded Institution was to send out circulars requesting information about mounds, monuments, and other evidences of former occupation which was to be used in the preparation of an "Ethnological Chart" showing the location of all such remains in every part of the country. The response was immediate and most satisfactory. The practice was continued over a period of years, later requests being expanded to include all types of anthropological information, with an impressive body of data being accumulated. Several maps were drawn from them, at different times, and all proved of value in the advancement of the plans for specific investigations. At the same time Secretary Henry stressed the importance of prompt and continuing archeological excavation to preserve evidence that was rapidly being destroyed by the plow. As a result, many local groups and societies dug sites in their areas, following instructions sent out from the Institution, and much was accomplished.

Directions for collecting Indian vocabularies and other linguistic information were also sent to teachers, missionaries, professional men, Army officers, government officials, and the factors of trading posts wherever tribes were located. A gratifying series of manuscripts valuable for studies in comparative linguistics were sent in from all parts of North America, the Russian Telegraph and Hudson's Bay Companies being particularly helpful in this respect. The material thus received was lent to various scholars and subsequently appeared in their publications, some of which were issued by the Institution and others by outside organizations. The manuscripts, however, were retained by the Smithsonian as source material. During the period when Lewis Henry Morgan was carrying on the investigations that culminated in his "Systems of consanguinity and affinity of the human family," the Institution, with the sanction of the Department of State, contributed to his efforts by sending questionnaires to qualified individuals in different parts of the world asking for pertinent information about the natives in the countries where they were located. The replies were forwarded to Morgan and played an important part in the preparation of the manuscript later published by the Institution. This method of obtaining data proved so successful that on occasions it is still used. The Smithsonian researches in anthropology have benefited greatly from the aid of the thousands of volunteer collaborators who have furnished information in response to such questionnaires.

Probably the greatest contributions to anthropology during Secretary Henry's tenure of office were in the printing of memoirs, monographs, and reports. The first scientific publication of the Institution, Vol. 1 of the *Smithsonian Contributions to Knowledge*, was the well-known "Ancient monuments of the Mississippi Valley," by E. G. Squier and E. H. Davis. When it appeared, requests for copies were so numerous that Henry wrote: "If all were granted it would completely exhaust all of the income of the Institution." The second volume contained Squier's "Aboriginal monuments of the State of New York," while C. Whittlesey's "Descriptions of ancient works in Ohio" appeared in the third. The fourth was devoted entirely to S. R. Riggs' "Dakota grammar and dictionary." Scattered through subsequent volumes were such papers as I. A. Lapham's "Antiquities of Wisconsin," S. F. Haven's "Archeology of the United States," T. J. Bowen's "Grammar and dictionary of the Yoruba language," J. G. Swan's "Indians of Cape Flattery," Morgan's previously mentioned "Systems of consanguinity" (a controversial work when it first appeared and one which even now is much debated in anthropological circles), Swan's "Haidah Indians of Queen Charlotte's Islands, British Columbia," Joseph Jones' "Explorations of the aboriginal remains of Tennessee," S. Habel's "The sculptures of Santa Lucia Cosumalwhuapa, in Guatemala, with an account of travels in Central America and on the western coast of South America," and W. H. Dall's "On the remains of later prehistoric man, obtained from caves of the Aleutian Islands."

During these years the appendices of the Annual Reports also contained numerous articles and reports of varying length on anthropological subjects. Considerable knowledge about developments in Europe was diffused in this way, and from their pages many American readers first became informed about the geologic antiquity of man, the Danish kitchen middens, the Swiss lake dwellers, and the determination of the ages of stone, bronze, and iron. Brief notices and longer articles describing finds and discussing ethnological studies in the New World were also included. A very helpful feature, started toward the

end of Henry's regime and continued for a number of years under Baird, were the bibliographies and summaries of general progress in anthropology prepared by Otis T. Mason, of Columbian College (George Washington University), Washington City. Publication of articles in the appendices of the Annual Reports has, of course, continued to the present. In recent years many anthropological items have been printed in *Smithsonian Miscellaneous Collections,* one of the more notable examples being Charles Upson Clark's translation of Espinoza's "Compendium and description of the West Indies." This early 17th-century treatise on Spanish America is a veritable treasure house of ethnological and historical information.

Cooperative projects were mainly along archeological lines, although other branches were not neglected. The Institution shared with the Historical Society of New York the costs of Squier's original surveys and explorations of the remains in that state. It joined with the Antiquarian Society of Worcester in furthering Lapham's work on the antiquities of Wisconsin. When the Peabody Museum was established at Harvard University, the Smithsonian invited it to join in a program of mound excavation in Kentucky, and some years later the two cooperated in making casts of the heads and faces of the Indians held prisoners at St. Augustine, Florida. The Institution and the Academy of Natural Sciences of Philadelphia together gathered information to be used in a study of the physical nature of European man in America. It cooperated to a greater or less extent, over a period of years, with the Chicago Academy of Sciences in collecting ethnological material from the Arctic regions. A group of collaborators to promote the study of American Indian linguistics was formed under its direction. These men—Alexander S. Taylor, of California; George Gibbs, of Washington Territory; Buckingham Smith, the Spanish scholar and historian, of Florida; and J. G. Shea, of New York—were to obtain information about all existing manuscripts in Indian languages with a view to publishing at least one grammar and dictionary of each of the representative languages of North America. Such material as was obtained was turned over to Dr. Shea, who was then preparing a "Library of American Linguistics," the Institution helping him by purchasing a stated number of copies of his works and distributing them to learned societies and libraries. The influence of Gibbs and Shea was important, and the assistance given by the Institution in promoting and diffusing their ideas was most opportune.

Another field of cooperation was that of the numerous government exploration parties, inaugurated shortly after the end of the Mexican War and the founding of the Institution. These boundary and railroad surveys and miscellaneous War and Navy Department expeditions, acting at the suggestion of, and under instructions from, the Smithsonian, obtained considerable anthropological material as well as that pertaining to natural history in general. The series of explorations was interrupted by the Civil War, however, and when the new surveys were started after its close, the Institution did not have as active a part in them as previously. A single exception was that of the Colorado River surveys of Maj. John W. Powell (1867–69), which were fostered by Secretary Henry. In 1871 they were extended into a geographical and geological survey of the Rocky Mountain region by a grant from Congress and were continued under the direction of the Smithsonian until 1 July 1874, when they were transferred to the Department of the Interior. The anthropological researches initiated by Powell during these years eventually had an important bearing on developments in the Institution. Upon his departure, Secretary Henry turned over to Powell all the ethnological and linguistic manuscripts in the Institution's files for use in furthering his studies.

Anthropology in the Museum

In the beginning it was not planned to make extensive collections of ethnological and archeological specimens for either study or exhibit purposes. A greater part of such as were received was turned over to men engaged in making special studies—such as Jeffries Wyman at Harvard, who received most of the human crania—or to museums and societies which were assembling objects of that nature. When Prof. Baird became assistant secretary, he made it a practice to retain a few choice articles, but it was not until after the collections of the U. S. Government were transferred from the Patent Office to the Smithsonian in 1858 and appropriations were made by Congress to support a museum that a definite program for assembling anthropological objects was started. Included in the Patent Office collections were items obtained by Lewis and Clark in 1803, by Gen. Cass in the Northwest Territory in 1820, and by the Wilkes Exploring Expedition in 1838. These 500-odd specimens were the nucleus to which were added the materials gathered by the boundary and railroad surveys; the Treasury Department's expedition to the new Territory of Alaska; the later Hayden, Wheeler, and Powell explorations; the special collections made by W. H. Dall, Edward Palmer, E. W. Nelson, and Lucien M. Turner, of the U. S. Signal Service, Roderick MacFarlane, of the Hudson's Bay Company, and the Rev. W. W. Kirby; the artifacts uncovered by excavations; and the articles sent in from America and

other parts of the world by volunteer contributors. In 1868 the Institution made an agreement with the Surgeon General whereby all its human crania and anatomical specimens were transferred to the Army Medical Museum in exchange for all ethnological material gathered by Army surgeons and other officers throughout the country. This increased the material-culture collections but delayed for many years the development of the study of physical anthropology in the Institution.

Great impetus was given to the gathering of Indian costumes, weapons, and other objects of their handicraft through Congressional appropriations for displays to illustrate the native American cultures at the Centennial Exhibition at Philadelphia. The actual collecting was done by, and at the expense of, the Bureau of Indian Affairs with the cooperation of the War and Treasury Departments and the U. S. Coast Survey, but the direction of the work and the preparation of the exhibits were entrusted to the Smithsonian Institution. Both archeological artifacts and objects made by the living Indians were included. In addition, many individuals, in response to requests prepared by the Institution and circulated by it and the Indian Bureau, sent specimens from all parts of the United States, Alaska, Puerto Rico, El Salvador, Costa Rica, Peru, Mexico, and the Samoan Islands. The work became so involved that Prof. Baird was no longer able to take full personal charge, and Edward Foreman was made assistant in ethnology. Otis T. Mason was appointed a resident collaborator and prepared plans for the exhibits at Philadelphia. Charles Rau aided as a collaborator but was soon named assistant in archeology, and Frank Hamilton Cushing was added as another assistant in ethnology. These men prepared the specimens and installed the exhibits at Philadelphia. When the collections, including those sent by foreign governments, were returned to Washington and to the Smithsonian Institution, Rau, Foreman, and Cushing were made permanent members of the organization and became the first anthropological staff of the now legally designated National Museum.

The Division of Anthropology was not established as such until 1883. When first organized, it contained three Departments: Arts and Industries, Races of Men, and Prehistoric Archeology. This was changed the following year, Ethnology being substituted for Races of Men, and Antiquities and American Prehistoric Pottery for Prehistoric Archeology. At this time Prof. Mason was named curator of Ethnology; Dr. Rau, curator of Antiquities; and W. H. Holmes, honorary curator of American Prehistoric Pottery. The assistant director of the Museum acted as curator of Arts and Industries, a department with seven sections. The Division was all inclusive, comprising the products of civilized as well as semi-civilized, barbaric, and savage peoples. Some years later (1897) the Museum was reorganized. The system of head curators was installed, and there was a reversal of nomenclature. The major groupings became departments, and the subgroups, divisions. The sections retained their former status. W. H. Holmes became the first head curator of the Department of Anthropology and, as such, supervised the Divisions of Ethnology, Historic Archeology, Prehistoric Archeology, Technology, Graphic Arts and its Section of Photography, Medicine, Religions, and History and Biography. In 1903 a Division of Physical Anthropology was added. As time went on, a number of the divisions and sections became sufficiently distinct and specialized to warrant detaching them from anthropology, and they either were made autonomous units, such as the Division of History, or were transferred to a new and separate Department of Arts and Industries, formed in 1919. Subsequently other divisions and sections were combined. The Department now consists of the Divisions of Archeology, Physical Anthropology, and Ethnology. The curator of the latter also has charge of the Sections of Period Art and Textiles, Heating and Lighting, Ceramics (including glass and silver), and Musical Instruments.

During its entire history anthropology in the Museum has had two main aims. These are (1) well-arranged displays of anthropological material for the benefit of the community at large, the thousands of visitors who annually visit its exhibits, and (2) large reserve collections available for study by those engaged in original researches. The Institution was a pioneer in the installation of life-sized groups depicting activities of the New World aborigines and in the use of scale models to illustrate Pueblo villages and cliff dwellings in the Southwest and types of Indian communities in other parts of the country. Beginning with Dr. Rau and Prof. Mason, the curators have divided their time between classifying, preserving, and arranging the collections and writing papers based on them. To this, of course, has been added original investigations in the field and the gathering of specimens to fill gaps. These extensive collections, now totaling 728,318 catalogue numbers, have been in constant use not only by members of the Institution's staff but also by students from all parts of the world. Many important articles, memoirs, and monographs have been based on them. These have appeared in the Annual Reports of the U. S. National Museum, the Museum Bulletins, in other of the Institution's series, and in numerous outside publications. Among the many studies may be mentioned those by Rau on stone implements; Mason's exhaustive articles

on throwing sticks, aboriginal basketry, bows and arrows, primitive travel and transportation, and cradles of the North American Indians; those by J. G. McGuire on primitive methods of drilling, and pipes and smoking customs of the American aborigines; the papers of W. H. Holmes on Indian pottery and on the lithic industries; Thomas Wilson's descriptions of arrowpoints, spearheads, and knives of prehistoric man; Hough's studies of fire-making and lighting equipment; Frances Densmore's work on musical instruments; and Hrdlička's numerous papers on the skeletal material. In the latter connection it should be mentioned that, following the organization of the Division of Physical Anthropology, the Army Medical Museum returned all the crania and skeletons transferred to it under the agreement of 1868 and many additional specimens acquired by it in the ensuing years. This formed the basis for what has now become one of the largest series of human skeletal material of its kind in the world.

Original anthropological explorations by members of the Institution staff had their beginnings in 1868–69, when Prof. Baird, impressed by similar work in Europe, examined a cave in central Pennsylvania for signs of "early man" and began excavations in shell heaps around the Bay of Fundy. Powell's work among the Indians in the Rocky Mountain region during these years might be construed in the same light, but at that time he was not in the true sense of the word a member of the Institution staff. The sponsorship of those particular investigations is more comparable to the practice of preceding years, when qualified men from the outside were asked to undertake specific tasks and were only temporarily associated with the Institution. A few years after Baird's excavations Cushing was detailed from the Museum to join Henry J. Biddle, of Philadelphia, in the exploration of a cave near Hagerstown, Maryland. This was followed by Cushing's examination of newly discovered aboriginal soapstone quarries in Virginia and on Soapstone Run, a branch of Rock Creek, in the District of Columbia.

The Bureau of American Ethnology

Extensive and intensive field work actually had its inception in 1879. In that year Congress passed an act discontinuing the four surveys then operating in the Western Territories and established the U. S. Geological Survey. The act also provided for the continuance of the anthropological researches that had been carried on by the surveys and directed that all the materials which had been gathered should be turned over to the Smithsonian and that the Institution assume responsibility for furthering the investigations. Powell, who was mainly responsible for the program of Indian studies in the surveys, was asked to direct the work for the Institution and proceeded to organize the Bureau of Ethnology, the adjective American being added to the title in later years. This was the first, and for a long time the only, example of a government agency committed to a systematic study of its native peoples and one which subsequently served as a model for others elsewhere. Appropriations for the continuance of these researches have been made annually by Congress since that time. A year after the founding of the Bureau, Powell was also appointed director of the Geological Survey and served in both capacities until 1894, when he resigned from the Survey and devoted all his energies to the Bureau. Succeeding heads of the organization have continued its operations in large part along the lines laid down by Powell.

At first, plans were to restrict investigations to the living tribes and tribal remnants in order that rapidly passing facts might be preserved. In 1881, however, as a result of popular petition, Congress enlarged the scope of the Bureau and specifically required that researches pertaining to prehistoric remains in the United States be undertaken. From them until now both fields have occupied the attention of members of its staff, although until recent years most efforts were directed to studies of the living Indians. At present, because of changing conditions, more of the researches are in archeology. As the work progressed it became evident that the Indians of the United States were only a part of much larger and more widespread problems, and the field of studies was broadened until it now includes all of North, Middle, and South America and the Hawaiian Islands.

The researches of the Bureau have been based on actual investigations in the field, either in the observation of peoples or in the excavation of archeological sites, and the subsequent study and correlation of data thus obtained. After their study has been completed, all ethnological, archeological, and skeletal specimens derived from this work are turned over to the Museum. The results of the researches and the conclusions reached have been published in part or in full. When of widespread general interest, they have been given extended treatment. When of a highly technical nature or of interest to a limited group, as in linguistics, only typical examples have been printed, the mass of the material being held for comparative study. The Bureau has several thousand ethnological and linguistic manuscripts of this type, including most of those which were collected by the Institution during its early years, turned over to Powell when he went to the Department of the Interior, and brought back

when he returned in 1879. They contain valuable source information and are in constant use by students.

The publications of the Bureau consist of 62 Annual Reports, 143 Bulletins, and 12 Miscellaneous Publications. It collaborated in the preparation of six *Contributions to North American Ethnology*. This series was started by Powell when he was in charge of the Geographical and Geological Survey of the Rocky Mountain Region, and two volumes were published before he organized the Bureau. Although the series was actually transferred to the Bureau and all the editorial work involved in the issuance of the last six volumes was under its jurisdiction, all appeared under the imprint of the Survey. The first 47 Annual Reports contain, in addition to the administrative report, ethnological papers and monographs treating of all phases of aboriginal life and numerous archeological reports. The 48th contains an index to all preceding reports, while those from 49 through 62 are wholly on the administrative work. The Bulletins comprise articles, memoirs, and monographs on language, native arts and industries, institutions and organizations, myths and beliefs, ethnobotany, ethnogeography, bibliographies of Indian languages, physical anthropology, and archeology. Bulletin 30, consisting of two volumes, is the *Handbook of the American Indians north of Mexico*; Bulletin 40, also in two volumes, is the *Handbook of American Indian languages*; Bulletin 78 is the *Handbook of the Indians of California*; while Bulletin 143, of which two volumes have just appeared, two are in press, and the fifth is ready for the printer, is the *Handbook of South American Indians*. The last is a joint project with the Department of State's Interdepartmental Committee on Cultural and Scientific Cooperation and includes the work of some 70 scholars in the American Republics. The Miscellaneous Publications are mainly circulars of directions and forms prepared for the use of collaborators and staff members working in the field. The Contributions contain ethnological, linguistic, and archeological papers. All the volumes in the several series are standard references and are in continual demand by libraries, universities, professional anthropologists, and students in all parts of the world.

The printing of manuscripts by the Bureau has not been restricted to those prepared by members of its own staff and the men in the Department of Anthropology at the Museum. The work of experts affiliated with other scientific institutions, colleges, and universities and that of qualified independent investigators have been included. Throughout its 67 years of activity the Bureau has made extensive use of collaborators and contributors, and many of its important additions to anthropological knowledge were derived from such sources. Included in this category are such well-known names as Jeremiah Curtin, Daniel G. Brinton, Charles P. Bowditch, Stephen Powers, H. L. Morgan, Franz Boas, Roland B. Dixon, Alexander F. Chamberlain, E. Förstemann, E. Seler, Garrick Mallery, Washington Matthews, H. C. Yarrow, John Murdoch, W. H. Dall, Stewart Culin, Alfred L. Kroeber, Waldemar Bogoras, Frances Densmore, and Elsie Clews Parsons.

Current investigations by the Bureau include explorations in the Veracruz area of Mexico in cooperation with the National Geographic Society, and in Peru, where a program for a study of the Virú Valley is being carried on in cooperation with Yale University, Columbia University, the American Museum of Natural History, the Chicago Natural History Museum and the Instituto de Etnologia de Perú; linguistic studies of the Kiowa and certain California tribes; ethnological observations among the Iroquois of northern New York and southern Canada; and studies pertaining to the "early man" problem in America, a subject to which the organization has made definite contributions through its discoveries relating to so-called Folsom Man. Furthermore, the Smithsonian Institution, through the Bureau, is cooperating with the National Park Service, the Bureau of Reclamation, and the Corps of Engineers in initiating a program to save as much as possible of the archeological evidence from sites to be inundated by the construction of dams and formation of large reservoirs in many of the river systems of the United States. Three survey parties are at present locating such remains in the Missouri River Basin, and additional groups are expected to start in other basins by late summer or early fall.

The Institute of Social Anthropology

The newest anthropological unit established in the Institution is the Institute of Social Anthropology, which was created in 1943 to carry out cooperative projects in anthropological teaching and research. This is part of the program of Cultural and Scientific Cooperation with the American Republics, organized by the Department of State. The Institute is supported by funds transferred to the Smithsonian by the Department of State from funds appropriated by Congress. The cooperative programs of the Institute have two objectives: (1) to introduce modern social science theories and techniques to other countries so that they may train their own scholars for such work, and (2) to accumulate basic social science data about the rural populations in those countries. The work in general is closely allied to that of rural

sociology, but the approach is anthropological. A series called *Publications of the Institute of Social Anthropology* has been established, in which the results of the field studies appear. These monographs contribute to a broader knowledge of the social sciences and furnish material, comparable in scope and purpose to studies made in other parts of the world, that may be used in arriving at generalizations concerning culture processes and culture changes. They also provide information that may be of help to administrators whose duty it is to carry out practical programs among peoples whose basic cultures are being greatly affected by the growth and changes in present-day civilization.

Since its organization, the Institute has had members of its staff in Mexico, cooperating with the Escuela Nacional de Antropología; in Peru, working with the Instituto de Estudios Etnológicos and the Ministry of Education; and in Brazil, assisting the Escola Livre de Sociología e Politica de São Paulo. The contemplated expansion of the general cooperative program to the Eastern Hemisphere suggests the possibility of the Institute's eventually having projects in the Near East, China, and Russia.

During the war period members of the various anthropological staffs in the Institution devoted much of their time to searching out and preparing information about native peoples and little-known parts of the world and to writing pamphlets and handbooks for various branches of the armed services. This work was coordinated by the Ethnogeographic Board, an organization set up as a joint project of the Smithsonian Institution, the National Research Council, and the American Council of Learned Societies. The offices of the Board, which went out of existence on 30 June 1946, were in the Smithsonian Building.

Throughout the history of the Bureau of American Ethnology, the Department of Anthropology, and the recent Institute of Social Anthropology, there has been no duplication of effort. The researches and other work have been planned and carried on as an integrated whole. The activities of each unit supplement those of the others, and in conjunction the three comprise the Smithsonian program for anthropology.

The Smithsonian: Pioneer in American Geology

Ray S. Bassler

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ROCKS, MINERALS, AND FOSSILS are popularly regarded as the sole objects of the geologist's study. The rocks do, indeed, furnish basic ideas of the earth's composition and history; the minerals are their expressions in chemical form or their artistic representations as gems; and the fossils reveal the story of prehistoric life, its environment, and its development. The natural science geology is, however, a broader subject, because it records the entire history of the earth and its inhabitants from our planet's origin in the sun to the present. Thus, geology is a composite science in which astronomy, biology, physics, and chemistry, contribute toward unraveling this complicated history. Furthermore, its findings lead directly to the modern sciences of economics, history, geophysics, and other subjects. It is in this larger sense that some of the pioneer researches of the Smithsonian Institution are here outlined. Since 1846, geologic research in many of its phases has been fostered and encouraged by the Institution and in some instances has been personally cultivated by its secretaries. This broad conception of the science is illustrated in Elliot's large mural painting, "Diana of the Tides," overlooking the dinosaur hall of the Natural History Building. Although primarily intended to represent the story of mythology, "Diana" does in fact picture astronomy, physical geology, petrology, sedimentation, fossils, glaciation, and other subjects of geological inquiry.

Progress in the earliest days of American geology was made largely by men engaged in the "learned" professions who pursued its study as a hobby. At that time there were no maps and no railroad cuts where the rocks were exposed to view; in fact, the country was largely a wilderness. It was logical, therefore, that certain gigantic fossil bones found weathered out at the surface in western Virginia (now West Virginia) should be investigated first. These were described by Thomas Jefferson as *Megalonyx*, which later was found to be not a lionlike animal, as he thought, but a giant sloth. When Jefferson became President, he continued his paleontological studies and had in the White House more than 300 fossil bones, chiefly from Big Bone Lick, Kentucky.

The James Smithson bequest came at an opportune period in the history of American geology. During this very year or shortly afterward New York and 12 other states inaugurated state geological surveys, being preceded only by North Carolina in 1824 and Tennessee in 1831. These early surveys were primarily charged with such essential projects as preliminary mapping, soil and mineral analyses, and other require-

ments of an undeveloped country, so that practically not even a beginning could be made on research problems. The need for a research institution, as visualized by Smithson, was paramount.

Smithson himself was interested in geology, for among his 27 publications in science several deal with the origin of the earth and with analyses of minerals and chemicals. His studies of zinc minerals indicated a new species, a carbonate, to which the name "smithsonite" was applied by subsequent investigators. His personal collection of minerals came with the bequest as the first geological donation to this Institution.

Several friendships of this early period are of interest in foreshadowing the future progress of geologic science in America. Just previous to Smithson's gift there appeared in the geological field a man of untiring energy, Amos Eaton, who at the age of 40 abandoned his law practice to study geology. Subsequently he traveled several thousand miles on foot through New England and New York, delivering short lectures on natural history. While Eaton was teaching at Rensselaer Polytechnic Institute at Troy, New York, a young man, an amateur collector, fell under his spell. Thus started the distinguished career of the first state geologist of New York, James Hall, who for more than half a century was the predominating figure in American geology and invertebrate paleontology. Eaton's lectures had a similar effect upon another young man, Joseph Henry, who had dreamed of a life devoted to poetry and drama but who now changed his aspirations to the fields of science. Eaton, when commissioned in 1820 to conduct an agricultural and geological survey of Albany County, New York, chose as his assistant the same Joseph Henry, the future first secretary of the Smithsonian. Henry was therefore a geologist first, as evidenced by his collections made on this soil survey and still preserved at the New York State Museum. Hall and Henry became close friends and remained so throughout life to the benefit of American science. In the conduct of his New York survey Hall owed much to Henry's wise counsel, while Henry similarly benefited from Hall's experience as a geologist.

Geography

Geography deals with the most recent period of earth history and thus is present-day geology. So much of the land areas was practically unknown in 1846 that the Institution early decided to foster geographic explorations to the extent of its ability. Financially it was unable to equip large expeditions, but the service rendered by the loan of its personnel and by the preparation and publication of the results caused it to play a more important part than is popularly believed—indeed, to contribute a real service to mankind at this time. The natural-history specimens, rocks, fossils, animals, and plants derived from these expeditions were fertile sources of increase to the collections and, through their study, to scientific knowledge. Since the greater part of the United States west of the Mississippi River was unknown at this time, it was natural that these explorations were usually organized under the branches of the general Government. Earliest of these were the expeditions conducted by the War Department to discover practical railroad routes to the West. These were accompanied by geologists, biologists, and ethnologists, who received their instructions from the Institution. Maj. J. W. Powell's famed exploration of the Colorado River, partly at the Smithsonian's expense, was undertaken at this time. In these pioneer days experts of the Smithsonian were also engaged in cave investigations on the Island of Anguilla to throw light on the life and the geography of the West Indies in prehistoric times. Later, parts of Asia were explored, particularly by Raphael Pumpelly, one of the first Americans to travel extensively through China and Mongolia. In the researches published by the Smithsonian, Pumpelly described the geological features of large parts of this vast area. Parts of Africa too were visited at this early date by Americans associated with the Smithsonian, which in many cases published the results of their explorations.

Paleogeography

From geography one passes to paleogeography, the science of mapping the ever-changing lands and seas of geologic times. The inauguration of this branch of learning in America can be attributed to Smithsonian scientists. Just as modern animals and plants are classified according to definite areas of geographic distribution, so the ancient assemblages of life, the fossil faunas and floras, can also be so delimited. Sea animals and the sediments in which their remains were buried were certainly not deposited on dry land. Consequently, it can usually be safely assumed that the ancient shore line has been reached when a rock layer with marine fossils has been traced to the point where it thins out and disappears. Thus, by plotting the distribution over wide areas of sedimentary rocks of a particular age, as determined by their contained fossils, the arrangement of land and water of that time—in other words, the ancient geography or paleogeography—can be ascertained. Phosphate deposits formed along old shore lines, salts representing the evaporation product of ancient lagoons, bog iron ores, and indeed many other mineral deposits depended for their formation upon ancient geographic conditions.

Paleogeographic maps can be prepared in such detail as to be of service in the search for such mineral and other economic deposits provided the fossils have been studied in advance. The paleontologist is naturally the best person to prepare accurate paleogeographic maps. Although various generalized maps were outlined in Europe and America some years before, it was not until 1902, when Charles Schuchert, then assistant curator in the National Museum, and E. O. Ulrich, honorary associate in paleontology, combined their knowledge and experience with Paleozoic fossils and produced the first set of detailed maps of that era. This pioneering work has been followed by others to such an extent that paleogeography is now a firmly established and very useful division of geology.

Glacial Geology

The weather, operating through the cold climates of high altitudes and arctic latitudes with the formation of vast areas of glacier-covered country at various times in geologic history, has had much to do with the formation and distribution of rich areas of soil as well as barren, boulder-strewn regions and outcrops of bare rocks exposing their mineral contents. Louis Agassiz in 1834 observed that the boulder and clay beds of the plains of Switzerland were identical in character with the deposits made by the present-day Swiss glaciers. With the promulgation of Agassiz's glacial theory the science of glaciology was inaugurated, but the proof of the theory had to be established. Secretary Henry, realizing the importance of glacial studies to the widespread drift and terrace deposits of the United States, was soon interested in sponsoring and publishing researches upon the subject. It was thus that in 1857 Edward Hitchcock's "Illustrations of surface geology" and in 1866 Charles Whittlesey's "On the fresh-water glacial drift of the northwestern states," as well as various succeeding papers published by the Institution, had their part in the proof of the theory. Today glaciology is such an important science that separate divisions for its study have been established in the Federal and State Geological Surveys and in many universities.

Chemical Geology

In the act establishing the Institution provision was made for a chemical laboratory. This was frequently occupied by students engaged in the "chemical analyses of soils and plants," researches mentioned in the plan of organization as a means "to increase knowledge." Results from this laboratory often formed the subjects of lectures delivered in the Smithsonian hall, commencing as early as 1848. In 1853 the laboratory was being used for the examination of American minerals by the early American mineralogist, J. Lawrence Smith, who followed his researches with a series of analyses of meteorites, among which were 14 belonging to the cabinet of James Smithson. This pioneer work anticipated the classic studies in chemical geology of George P. Merrill, head curator of Geology in the latter part of the century, and his volumes of research on meteorites, building and ornamental stones, and rock weathering and soils.

Paleontology

The facts of paleontology provide a standard for the subdivision of geologic time, which in turn permits an application to many practical affairs. The physical phenomena, such as rainfall, weathering of the rocks, and deposition of sediments under water and on the land, have operated essentially the same throughout the earth's history, but species of animals and plants, although remaining stable for centuries, do change in various ways, through evolution, as time goes on. Thus, only the simplest forms of life are found as fossils in the oldest stratified rocks, and increasingly complex species occur in the sediments of more and more recent periods. It follows that if sedimentary rocks in widely separated areas contain the same species of fossils, these were deposited more or less contemporaneously. Knowledge of these species, therefore, helps to identify or correlate rocks of the same age in different parts of the world. Such knowledge is useful also in the search for economic products and is required in the identification of the faults, folds, and other dislocations of the strata encountered in structural geology. The paleontologist is primarily concerned with the description and correct naming of these ancient animals and plants in anticipation of their use in other branches of geology.

The Smithsonian has been active in paleontologic studies ever since the explorations undertaken in its earliest days. This work was conducted primarily for the advancement of knowledge, but today the successful paleontologist must be more practical. He must also be a stratigrapher and a structural geologist, first to correlate the strata and then to determine their underground relationships. Charles D. Walcott, the fourth secretary of the Smithsonian, was an outstanding example of this rare combination of talents. Starting in 1876 as assistant in paleontology to James Hall, Walcott soon advanced to the position of assistant geologist on the newly organized U. S. Geological Survey. Then in 1883 he became, in addition, an honorary curator of the National Museum, where he continued his work of research and upbuilding of the geological collections until his appointment as director of the Survey in 1894, and as secretary of

the Smithsonian in 1907. Walcott pioneered in structural geology with his studies and publications in 1890 on the faulting and folding of the Grand Canyon area. His studies of the stratigraphy and paleontology of the oldest rocks of the earth's crust and of the succeeding Cambrian period brought him world-wide recognition as well as renown to the Smithsonian for his association with it. Younger members of his staff, working under his inspiration, have carried on investigations more intensively in the paleontology and stratigraphy of the succeeding periods of time and the Smithsonian publications now give a fair review of the entire geological column.

Micropaleontology

The Smithsonian Institution is a conspicuous example of a research organization devoted primarily to pure science which has seen its results applied to the most practical things. For example, the petroleum industry has particularly benefited from the activities of Smithsonian scientists through their intensive study of micropaleontology, the science comprising the various groups of fossil microscopic organisms, Foraminifera, ostracods, conodonts, bryozoans, and diatoms. Joseph A. Cushman, distinguished collaborator of the Smithsonian since his earliest studies of the Foraminifera, was the first to demonstrate their practical value in commercial work. Now the petroleum geologists particularly desire publications treating in a comprehensive way of the fossils from widely scattered areas and various periods of geological time. Fossils of all sizes, from microscopic forms to the huge dinosaurs, are useful as guides to the age and structure of sedimentary rocks, but in the petroleum industry the minute species are most important. The reason for this is that, in drilling, the larger species encountered in the well are generally churned to pieces.

The Foraminifera, minute one-celled animals enclosed in porous shells, have long been considered the best of such guide fossils in oil geology, mainly because they have so far received the most study and have thus produced the best results. However, well drillings are often crowded with Ostracoda, minute bivalved Crustacea, and other classes of microscopic fossils that are found in stratified rocks of all kinds and ages from early geologic time to the present. Some types of rock, such as shale and sandstone, were deposited under conditions unfavorable to the development or preservation of Foraminifera and Ostracoda. Here the paleontologists may be fortunate in finding toothlike organisms called conodonts, which, although usually a millimeter or less in diameter, have great resemblance to sharks' teeth. The conodonts, however, became extinct many millions of years ago. A class that persisted throughout most of geologic time and is still abundantly represented includes the moss animals, or Bryozoa, which, although forming large colonies, can be identified by thin sections of minute fragments. The classification of the Bryozoa and Ostracoda and then the conodonts was placed on a firm foundation by Smithsonian students, whereupon interest in these groups was so stimulated that now scores of investigators carry on their study.

Vertebrate Paleontology

The Division of Vertebrate Paleontology has had a long and distinguished record of service in the Smithsonian's history. Beginning with the transfer of the National Cabinet of Curiosities in 1846, the fossil vertebrate collection showed a steady growth for several decades through the exploring expeditions of the General Land Office, Pacific railroads, the Army, and the early U. S. Geological and Geographical Surveys. In 1850, Joseph Leidy was commissioned as a collaborator of the Institution to study these collections, a task which occupied him for the next 20 years. Leidy's works, published in part in *Smithsonian Contributions to Knowledge*, were pioneer for the science and covered various fields, as evidenced by their titles: "Memoir on the extinct species of American ox" (1852), "Cretaceous reptiles of the United States" (1865), and many others. In the early 1870's commenced the contributions of E. D. Cope, following his appointment as collaborator in vertebrate paleontology with the Hayden Geological Survey. Cope's exploration of the western fossil fields and the many volumes and reports on vertebrate fossils published by various branches of the Government attest to his great activity, which is equally reflected in the enrichment of the National Museum collections. Cope was succeeded in 1882 by O. C. Marsh, who, in addition to his position as vertebrate paleontologist for the U. S. Geological Survey, was curator of the Department of Vertebrate Fossils at the Museum. During the next 10 years, with the aid of a large staff of assistants provided by the Survey, he was able to collect, prepare, and describe one of the most notable assemblages of fossil vertebrates ever made in the history of the science.

In spite of all this aid, great collections of vertebrate fossils remained for preparation and study at the time of Prof. Marsh's death in 1899. That this was carried on successfully by succeeding curators—Charles W. Gilmore for fossil reptiles, and J. W. Gidley and, more recently, C. L. Gazin for fossil mammals—is attested in the present exhibition halls and great study collections.

Paleobotany

The ground work of the science of fossil plants was laid in Europe as early as 1804, but it was not until

the latter half of the century that this study was inaugurated in America. Pioneers in the United States were Leo Lesquereux, with his studies on Alaskan fossil plants, and J. S. Newberry, with his studies of Tertiary plants from western United States, both sponsored and published by the Smithsonian Institution. They were followed by Lester F. Ward, curator of Paleobotany for many years and a great organizer and bibliographer whose researches for the Institution continued to enrich the science. Ward was fortunate in bringing to Washington two outstanding paleobotanists, David White and F. H. Knowlton, both then in their twenties, to carry on research as associate curators of the U. S. National Museum for the rest of their lives. White's work on the Coal Measures plants, especially of the eastern United States, is classic, while Knowlton's studies, first of the Fossil Forest and continuing with the Cretaceous and Tertiary floras of the western United States and Canada, resulted in many monographs forming the basis for subsequent researches in the present century.

Taxonomy

Finally, the Smithsonian has pioneered and has been active throughout its first century in its publications on taxonomy, a branch of learning little appreciated by the general public but a necessary adjunct in all branches of natural science. Rocks and minerals, animals, and plants have received special scientific names which necessarily must remain the same in all languages if they are to be useful as guides for students of all nationalities. Unfortunately, through lack of knowledge or other reasons the same species of rock or animal, for example, has often been described over and over again under different names, a proceeding that impairs its use in scientific work. Taxonomy, the science of systematic classification, remedies these defects in nomenclature. The student with access to an extensive library and a keen interest in reducing the duplicate names or "synonyms" to the original valid one will prepare catalogues, bibliographies, or indexes, whichever they may be called, a task requiring a comprehensive knowledge of the subject under study as well as extreme patience in searching the literature. Secretary Henry, the physicist, probably because of his association with paleontologist James Hall and with Prof. Baird, the naturalist who succeeded him, so appreciated the need for taxonomic research that the Smithsonian commenced publication on the subject as early as 1864 with F. B. Meek's check list of North American invertebrates. Within two years Conrad's work on Eocene fossils was issued, followed by a comprehensive catalogue of the Museum's Mesozoic and Cenozoic types. By 1876 studies in paleobotany had progressed to the point that a catalogue of Cretaceous and Tertiary plants by Lesquereux and later a similar but expanded work by Associate Curator Knowlton became necessary for proper bookkeeping in this study.

Invertebrate paleontology requires the largest number of publications to solve taxonomic problems. Scudder's "Nomenclator Zoologicus" (Museum Bulletin 19, 1882) dealt entirely with the proper classification of fossil and Recent genera. Assistant Curator Schuchert's bibliography of American fossil brachiopods (1897) was the last of such publications in the 19th century. Since 1900, however, more than 3,000 printed pages of synonymic bibliographies on Paleozoic invertebrate fossils alone, particularly echinoderms, Bryozoa, and Ostracoda, by members of the Museum staff, have been published and distributed to the libraries and interested students of the world.

Pioneers in a nation or an organization invariably bring its early days to mind. In a scientific institution such as the Smithsonian, even with its varied early interests, the term pioneer cannot be so restricted because of the new endeavors assumed as time passed. Accordingly, the Smithsonian has pioneered in quite recent years and expects to do so in the future, following Secretary Henry's original admonition always to cooperate to the fullest extent but not to compete with any organization doing the same type of work equally well.

Centennial Notes—

The first hundred years of the Smithsonian Institution **is the title of a finely illustrated, 64-page book by W. P. True, chief of the Editorial Division. This book, which is being published for wide distribution by the Institution, should prove of interest to the readers of *Science*.**

A new three-cent postage stamp **commemorating the Centennial of the Smithsonian Institution is being issued on 10 August.**

A Centennial Exhibit **is to open on 10 August in the foyer of the National Museum Building, Washington, D. C. The exhibit will continue through the month of September.**

—1846-1946

The Background of the Smithsonian's Museum of Engineering and Industries

Frank A. Taylor
Curator, Division of Engineering, U. S. National Museum

THE DEPARTMENT OF ENGINEERING AND INDUSTRIES of the National Museum has its roots in such old and diverse activities as the U. S. Exploring Expeditions of 1838–42 and the accumulation of experimental physical apparatus left by Smithsonian researchers. Its future is directed toward a full-scale development into a National Museum of Engineering and Industry within the Smithsonian family.

Though the Department's collections include some of the earliest accessions of the Institution, its history begins about 1880. G. Brown Goode, in charge of the National Museum, was convinced then that the great industrial expositions had proved the value of exhibition as a means of public instruction. He felt that if so much could be learned from exhibits that were unorganized and largely unexplained, a well-planned display of industrial and scientific material would be a contribution to education.

At the same time the old Armory Building and several sheds were bulging with collections acquired from exhibitors at the Centennial, and the first National Museum Building was nearing completion.

Dr. Goode drew up a provisional plan for the organization of the Museum, which he saw as a museum of anthropology in the most comprehensive meaning of the word. The Museum would exhibit all phases of human culture and industry. He suggested that exhibits be grouped to show the development of ideas and processes rather than according to geographical, racial, or tribal origins. He saw the most primitive tools and wares as the beginnings of series tracing their development to complicated modern machines or structures. Of 64 primary classifications tabulated in his plan, 49 related to Arts and Industries.

When the time came to move into the new building, it proved woefully inadequate to house the collections then on hand. The fine plan had little chance. A few exhibits, originated by Museum people or Smithsonian associates for the expositions and preserved intact, got off to a good start. The Section of Fisheries, for example, was launched with evening openings of its display, "illuminated with the latest equipment of the Brush-Swan Electric Light Company." Other exhibits in this group included Materia Medica, Naval Architecture, Food, Textiles, History, and Ceramics. Forestry, Graphic Arts, and Steam Transportation were soon added in an attempt to carry out the plan.

But the pressure for space to house laboratories, scientific workshops, and the growing collections in natural history not only hampered expansion but actually crowded out exhibits. So little remained at Dr. Goode's death that the Department was abolished, and the remaining sections were placed in other departments. The surviving sections were Medicine, Graphic Arts, including Photography, and Technology, which was a catchall for all others of the original activities. The orphaned and poverty-stricken nature of the work is indicated by the fact that a naval officer was assigned to the work headed Medicine, the Museum photographer made the Section of Photography his avocation, and the curator of Technology was the superintendent of buildings. These men, who held on in spite of obvious difficulties, were the real fathers of the present Department.

J. Elfreth Watkins was one of these. He came to the Museum from a successful railroad career, to be the unpaid curator of Steam Transportation. He visited museums and inspected transportation systems abroad at his own expense. His work was so favorably recognized that, without his knowledge, a memorial was presented to Congress over the signatures of practically every railroad official of the country, urging the expansion of the transportation collections according to Watkins' plan. The tiny space then available to him made the appeal somewhat pathetic. Watkins left the Museum in 1892 to plan and direct the outstanding exhibit of the Pennsylvania Railroad at the Columbian Exposition and then spent a year as the head of the Department of Industrial Arts at the Field Columbian Museum. When he returned to the National Museum, everything that was left of Arts and Industries except Graphic Arts and Medicine was grouped under his care; and, as mentioned above, he was the superintendent of buildings.

During his tenure he made many original studies in the field of engineering and railroad history, and reference is still made to his papers. Many of the rare old volumes relating to these subjects now in the Museum library were secured for his private library, while such items as the old locomotives "John Bull" and the "Stourbridge Lion" and the cylinder of the first steam engine in America represent the quality of the collecting done by him.

Among his more fortunate later undertakings was the creation of a Section of Electricity, with George C. Maynard in charge. Maynard was an electrician, which at the time meant that he was a physicist, elec-

trical engineer, and communications expert. He was an associate of Gardner Greene Hubbard and Alexander Graham Bell in the promotion of the telephone and manager of the Bell Telephone System of the District of Columbia. Because of Bell's work in aviation, Maynard was also interested in that field and, being of a family of firearms inventors, his collecting interests and qualifications were broad. Relics of the aviation pioneers, the earliest telegraphers, the telephone, and the beginnings of electromotive equipment were secured by him and are among the most valuable archives of these industries today. It is also most fortunate that he and Watkins were able to select the original models of basic American inventions from the Patent Office collection when that collection was at its best.

As the photographer of the Institution, T. W. Smillie collected for the Section of Photography so quietly that his amazing collection was well formed before the Museum people generally realized it existed. Smillie, a leading photographer of his time, worked out methods of photographing fish that proved invaluable in the Fish Commission's work of propagation; he was in charge of the photographic work for the Smithsonian at the solar eclipse at Wadesboro, North Carolina, in 1900; and he assisted Dr. Langley in photographic recording of the infrared spectrum and later with his records of birds in flight. He wrote on color photography and other advanced photographic processes. But his collecting will be his increasingly valuable monument.

The work of these men carried over into the revival of the Department beginning in the years 1910 to 1914, when the occupation of the new Museum Building released space in the old. This was a fresh opportunity. Richard Rathbun, then in charge of the Museum, reactivated and revived old sections, added new curators, and encouraged them in their work. Frederick L. Lewton, in Textiles, and Chester Gilbert, in Mineral Technology, sought the cooperation of industry, and many fine exhibits of current information in these fields resulted. World War I interrupted the work at its start, but the momentum carried it through, and after the war the Department assumed form and direction. Excellent collections and exhibits were developed in Wood Technology, Organic Chemistry, and Medicine, all within the Division of Textiles. The present head curator took over the Section of Technology left by Maynard. The organization was good, and enthusiasm was high, but it ran head on into a block—a Federal economy program. Some of the staff left, discouraged, and the old procedure of doubling up the work and combining sections was repeated. The effort and knowledge of the men who were left were again spread thinly over impossibly wide subjects. They did their best to keep up with developments in vastly expanding fields, making selective collections as opportunity afforded. At the same time they were pressing for recognition of the work which would raise it to the level of the other departments of the Museum and assure it of some continuity of effort.

A step forward appeared to have been made in 1932, when the Department was reorganized. For the first time it was headed by a head curator, Carl W. Mitman, who could visualize the work and future of the Department as a whole. Since 1920 Mitman had urged the development of the Department into a position comparable with national museums of science and industry elsewhere. His work in developing the plan for the new Museum of the Peaceful Arts in New York (1927) and firsthand inspection of the leading museums abroad had been encouraged and recognized by the Institution. In fact, his organizing abilities were so well recognized that he was assigned to head a succession of Institution-wide activities from 1932 to the present—to the substantial exclusion of departmental work. The Department still did not have the effective organization of the older units of the Museum, and its history up to World War II followed the earlier pattern.

The men fortunate enough to be able to devote their time to single activities accomplished much. Charles Whitebread kept the Division of Medicine abreast of modern developments in that field while collecting much of consultative value from the past. William N. Watkins built the collection of woods to rank with the one or two leading collections of the world while establishing his own scientific leadership in the taxonomy of woods. The fine national aircraft collection owes its present stature almost entirely to the work of Paul E. Garber.

One who worked successfully against the handicap of a fantastically broad field is Dr. Lewton, recently retired curator of Textiles. Dr. Lewton was called to the Museum in 1912 by Dr. Rathbun to head the revived Division of Textiles. He had had eight years with the Commercial Museum of Philadelphia as curator of economic botany, followed by distinguished service with the U. S. Department of Agriculture as a specialist in the breeding and acclimatization of tropical plants, particularly cotton. Most valuable to the Museum were his friendships with the manufacturers he had previously contacted to determine the qualities of raw cotton most desired by them for his guidance in the breeding work. At the Museum he dug into and salvaged what was recoverable of the old collections of foods and textiles, fought the dispersal of the Division of Medicine, and undertook to act as its head until a curator could be found. He was handed almost immediately the whole field of animal and vegetable products, together with forestry, and

in addition was required to perform the rough groundwork of reviving the Division of Mineral Technology. Without guidance, he set up a plan of organization for the development of these varied collections, but the implied necessity of implementing the organization with additional staff brought it an unenthusiastic reception. The plan recognized the threefold substance of the work: the custodial, or preservation of government-owned relics as required by law; the exhibition for public education and information (as well as for Institutional advertisement and public relations); and, in his mind most important, the development of record study collections of authenticated specimens of all of the industrial raw materials and foods. He included in the last the study collections of models and machines representing important inventions. Applied to his very broad field, the plan imposed a large task on him. With several sections of it in able hands, still too much was left for one man. That he did so well with all of it is a tribute to his skill and industry.

World War II shifted the emphasis from the development of the collections to the immediate and effective use of the collections and the expert skills of the staff. The Department performed creditable service in an almost incredible variety of ways. Practically every collection was consulted for solutions of problems and ideas on materials and processes to wage the war effectively. Wasteful reinvention of older ideas was frequently made unnecessary by the existence of an example of the old item, or the time for development was shortened if an old idea was found to be a solution.

Since the cessation of hostilities the Department's work is returning to normal. Collections have been returned from protective storage, and staff members are returning from service. The objective for the future is a department of national significance, with staff and sections adequate to the purpose of establishing the National Museum of Engineering and Industry.

A Century of Progress in Smithsonian Biology

Remington Kellogg
Curator, Division of Mammals, U. S. National Museum

THE SMITHSONIAN INSTITUTION from the very first was specifically charged with the responsibility for maintaining a museum. In December 1850 Assistant Secretary Baird submitted to Secretary Henry a detailed program of museum activities, which included provisions for the stimulation of scientific research and for scientific and educational publications. As specified in the original endowment, the Institution was founded "for the increase and diffusion of knowledge among men." Since the financing of "explorations in descriptive natural history" was the sole biological objective listed by Secretary Henry in the fall of 1847, when he presented the plan for the organization of the Institution under the terms of the Smithson bequest, the sponsored research was naturally in accord with this directive. To increase the existing knowledge of animal and plant life, various steps were taken to stimulate the collection of such materials and to encourage original investigations by competent workers. To diffuse the knowledge that resulted from studies on these collections, the Institution made provision for assistance in the preparation of illustrations and for the publication of monographs, revisions, and preliminary papers.

The descriptive zoologist or botanist is concerned primarily with establishing the diagnostic characters that differentiate living forms. By assembling for minute comparative study large series of specimens, all uniformly prepared or preserved, from all possible localities, taxonomists have been enabled constantly to advance human knowledge. Consequently, the descriptive phase of natural history is by no means static since the relative importance of characters selected as having diagnostic significance is continually being scrutinized.

The accumulated studies on the collections thus provide a means of measuring the progress made in this branch of biology during the past 100 years under the sponsorship of the Smithsonian Institution. The natural-history collections assembled under the auspices of the Smithsonian were originally largely North American, but in the course of time expeditions were sent to all parts of the world. Study of these materials, as here described, has helped to elucidate the floras and faunas of these regions. Since these contributions to natural history have resulted from investigations made by staff members, collaborators, and others aided by the Institution, it will be convenient to review the progress in the 10 divisions whose curators have had the responsibility for the improvement and care of the collections.

Mammals

Shortly after entering on his duties as assistant secretary in 1850, Spencer F. Baird brought his private collection to Washington, from Carlisle, Pennsylvania, and about the same time the Smithsonian Institution appro

priated a small amount for activities related to natural history. Baird was able also to have surgeons and field naturalists assigned to the various government explorations and surveys that preceded the construction of the first transcontinental railroads, and from them, as well as from other expeditions to which the Institution contributed financial support, voluminous collections were received. To these two sources were added in 1858 by transfer from the Patent Office the mammalian materials collected by the U. S. Exploring Expedition (Wilkes, 1838–42), and other early government collections were received in 1861–62, when the National Institute was dissolved. Baird utilized these combined collections in the preparation of his "North American Mammals" (1857), which for more than 30 years constituted a standard reference work.

To increase the knowledge of natural history Baird obtained the cooperation of most of the competent American naturalists of that time, including Harrison Allen, who in 1864 published his monograph on North American bats. In the early 1860's, when Theodore N. Gill, eminent as an ichthyologist, was young and ambitious, he commenced the preparation of a series of synoptic reports on the vertebrates. Although this work was never completed, Gill did publish reports on the seals (1866), sperm whales (1871), and insectivores (1875). The most comprehensive of these studies was his arrangement of the families of mammals (1872).

An examination of the Annual Reports of the Institution shows that no one was directly in charge of the collection of mammals prior to 1879 and that they were probably cared for personally by Baird. During that year the U. S. National Museum was organized by G. Brown Goode in accordance with instructions from Baird, and Elliott Coues was designated as curator of Mammals without compensation. Coues had previously written an account of the fur-bearing mammals (1877) and in coauthorship with J. A. Allen a quarto tome entitled "Monographs of North American Rodentia" (1877).

In 1881, Frederick W. True, librarian of the National Museum, became acting curator of Mammals, a post he held until 1908. He had been designated head curator of Biology on 1 July 1897, and had charge of the library and exchanges as assistant secretary of the Smithsonian Institution from 31 May 1911 until his death on 25 June 1914. True achieved world-wide recognition for his cetacean researches, of which the most notable were the reviews of the dolphins and smaller-toothed whales of the family Delphinidae (1889), the whalebone whales of the western North Atlantic (1904), and the beaked whales of the family Ziphiidae (1910).

Gerrit S. Miller, Jr., came to the National Museum in 1898 from the Bureau of Biological Survey and until his retirement at the end of 1940 had the actual responsibility of caring for the mammal collection. During those 42 years Miller took a leading part in the general advance of mammalogy. He was the author of nearly 400 publications, dealing for the most part with mammals and including "The families and genera of bats" (1907), "Mammals of Western Europe" (1912), "North American Recent mammals" (1924), and with Glover M. Allen the "American bats of the genera Myotis and Pizonyx" (1928).

Leonhard Stejneger was a member of the commissions that investigated for the U. S. Government the fur-seal herds of the North Pacific in 1895, 1896, and 1897. In 1922, at the request of the Department of Commerce, he visited again the northern fur-seal rookeries to determine the changes that had taken place since the international agreement of 1911.

Other important contributions[1] were made by Marcus Ward Lyon, Jr., who was appointed aid in the Division of Mammals in 1898 and resigned as assistant curator in 1912. While a member of the staff Lyon completed for publication the "Classification of the hares and their allies" (1904) and the "Treeshrews: an account of the mammalian family Tupaiidae" (1913). Ned Hollister transferred to the division from the Bureau of Biological Survey in 1910, but in 1916 he became superintendent of the National Zoological Park, a position he held until his death in 1924. Hollister's capacity for straight thinking is best shown in his taxonomic revisions of the muskrats, minks, grasshopper mice, and prairie dogs. His major contribution is generally considered to be "East African mammals in the United States National Museum" (1918–23).

For his explorations in the Malay Archipelago and elsewhere between 1888 and 1923, William L. Abbott will be classed among the most interested and generous benefactors of the Smithsonian Institution, and although he did not engage in taxonomic studies, large collections of natural-history specimens were made available by his efforts to those who were so interested. Edgar Alexander Mearns, who was associated with the Institution for many years as a collaborator, not only was the collector of large numbers of mammals and birds but also published one volume on "Mammals of the Mexican boundary of the United States" (1907).

Birds

For many years, during the formative period of American ornithology, the center of systematic studies on North American birds was located at the Smithsonian, where through the efforts of Baird the first large North American bird collection was assembled. Included among the older publications on birds that had considerable influence in stimulating and advancing the study of ornithology were "Birds of North America" (1858), by Baird, and the revised edition (1860) under the same title but published under the joint authorship of Baird, John Cassin, and George N. Lawrence.

A considerable number of bird students were given facilities for study by Baird, and one of these was Elliott Coues, an accurate worker noted for fluency and versatility in writing and the author of "Key to North

[1] Remington Kellogg, author of this article, came from the Bureau of Biological Survey to the Division of Mammals in 1928 as assistant curator, succeeding to full curatorship at the retirement of Mr. Miller in 1940. Dr. Kellogg's principal contributions to mammalogy have been concerned with marine mammals, both fossil and Recent. Also, he has participated in several international conferences on the regulation of whaling.—Editor.

American birds'' (1874), which subsequently passed through five editions. The bird biographies prepared by Coues for his ''Birds of the Northwest'' (1874) are still considered to be among the best.

After serving an apprenticeship from 1867 to 1869 as zoologist with the Geological Survey of the 40th Parallel under Clarence King, Robert Ridgway became a regular member of the Smithsonian staff. At first Ridgway was given the exacting task of preparing the technical descriptive material and certain of the illustrations for the treatise entitled ''History of North American birds'' (1874–84), which appeared under the co-authorship of Baird, T. M. Brewer, and Ridgway. Subsequently, ''A manual of North American birds'' (1887) was published by Ridgway, and a few years later he commenced work on the monumental ''Birds of North and Middle America'' (8 vols., 1901–19), which, however, was not completed during his lifetime. Dissatisfied with the inadequacy of the color terminology employed in technical descriptions of birds, Ridgway devised a plan for standardization of the named colors. The first edition was issued under the title ''A nomenclature of colors for naturalists'' (1886) and a second, more comprehensive edition, ''Color standards and color nomenclature'' (1912), was underwritten by the author aided by his friend José C. Zeledón, of Costa Rica.

During the early years of his association with the National Museum, Leonhard Stejneger devoted considerable time to avian studies. In addition to those dealing with the Japanese and Hawaiian avifauna, Stejneger made important contributions to ornithology in ''Outlines of a monograph of the Cygninae (swans)'' (1882), ''Results of ornithological explorations in the Commander Islands and in Kamtschatka'' (1885), and ''Natural history of birds'' in the Standard Natural History (1885).

Charles W. Richmond successively advanced from aid to curator in the interval between 1893 and 1932. Most of his life was devoted to bibliographic research. Aside from an unpublished card index of avian scientific names, which currently is widely used as a research tool, Richmond will be remembered for several installments of ''Generic names applied to birds'' (1902–27).

Extensive contributions to our knowledge of the birds of Eastern Asia, Malaya, the East Indies, and the Philippines have been made by members of this Division. Joseph H. Riley, who joined the staff as aid in 1896 and subsequently was promoted to assistant and associate curator, worked first with West Indian birds and then became a specialist on far eastern birds, particularly those of Mongolia, China, Siam, Malay Peninsula, northern Celebes, and islands off Sumatra and Borneo. Charles W. Richmond and Harry C. Oberholser, of the Bureau of Biological Survey, published a number of reports on the large collections of birds made by W. L. Abbott in the Dutch East Indies. Collections made by Abbott also formed the basis for ''The bird fauna of the West Sumatran Islands'' (1944) by S. Dillon Ripley. With firsthand information gained from two years' experience in the field (1935–37), Herbert G. Deignan, associate curator of Birds, wrote ''The birds of northern Thailand'' (1945). Edgar Alexander Mearns, associate in zoology, summarized the results of his field experience in eight papers on Philippine birds (1905–16).

The most comprehensive studies on the birds of some of the larger West Indian islands have been made here. Alexander Wetmore, secretary of the Smithsonian Institution, has reviewed the avifauna of two of these islands in ''Birds of Porto Rico'' (1927–28) and in joint authorship with B. H. Swales, ''The birds of Haiti and the Dominican Republic'' (1931). While a staff member of the Bureau of Biological Survey, Wetmore obtained the field data for his ''Observations on the birds of Argentina, Paraguay, Uruguay, and Chile,'' published by the Museum in 1926. Numerous contributions to the paleoornithology of North America have also been made by Wetmore.

Herbert Friedmann, who accepted the curatorship of Birds in 1929, has published reports on the birds of Ethiopia and of Kenya Colony (1930, 1937), and since the death of Ridgway has continued the publication of ''Birds of North and Middle America.''

During September 1883, Charles Emil Bendire accepted Baird's invitation to organize the collection of bird eggs, a task he continued to perform as honorary curator of the Department of Oology until his death in 1897. Bendire collated all available data in ''Life histories of North American birds, with special reference to their breeding habits and eggs'' (1892–95). On the death of Bendire, William L. Ralph was appointed custodian of the egg collection, and following the latter's death in 1907 these duties were assumed by the curator of Birds. More recently, Arthur Cleveland Bent, collaborator, has attracted wide notice for his comprehensive ''Life histories of North American birds,'' of which 14 volumes have now been published by the National Museum.

Reptiles and Amphibians

In the decade notable for exploration, large numbers of reptiles and amphibians were received from the field naturalists of the various government parties surveying the United States and Mexican Boundary and the parallels for a transcontinental railway. Consequently, work was begun without delay by Baird and Charles Girard on the herpetological collections, and by 1853 the ''Catalogue of North American reptiles in the Museum of Smithsonian Institution'' was published. Girard subsequently (1858) published the volume on herpetology for the U. S. Exploring Expedition (Wilkes, 1838–42), while Baird was the author of the ''Reptiles'' of the United States and Mexican Boundary Survey (1859).

Edward Drinker Cope, the master naturalist in the estimation of Henry Fairfield Osborn, began his studies on the herpetological collections of the Institution in 1860, and for many years thereafter incoming collections were sent to him for study and report. As a result of this collaboration, the Smithsonian Institution published for Cope ''The Batrachia of North America'' (1889) and ''The crocodilians, lizards and snakes of North America'' (1900).

When the National Museum was organized in 1878, Henry Creey Yarrow, an Army surgeon whose time was largely taken up by official duties at the Army Medical Library, was induced by Baird to serve as honorary curator of Herpetology, a post he felt impelled to relinquish in March 1889. Prior to this, Yarrow had prepared two reports on herpetological collections made while detailed as surgeon and naturalist to the U. S. Geographical and Geological Explorations and Surveys west of the 100th meridian. The main task undertaken by Yarrow at the Museum was the preparation of the "Check list of North American Reptilia and Batrachia, with catalogue of specimens in the U. S. National Museum" (1883).

From March 1889 until February 1943, the Division of Reptiles and Batrachians was supervised by Leonhard Stejneger. Among the sound and carefully considered contributions to that branch of zoology, which made Stejneger one of the world's foremost authorities, were "The poisonous snakes of North America" (1895), "The herpetology of Porto Rico" (1904), and "Herpetology of Japan and adjacent territory" (1907). Although his scientific investigations were curtailed somewhat by administrative responsibilities after 1911, when he succeeded F. W. True as head curator of Biology, Stejneger was engaged for many years in the preparation of a general revision of North American turtles, but only one section of this study, entitled "Notes on the American soft-shell turtles with special reference to *Amyda agassizii*" (1944), was completed for publication. Because of his wide knowledge of systematic zoology and his ability as a linguist, Stejneger took a prominent part in the formulation of the code of zoological nomenclature, beginning with the Fifth International Zoological Congress, held at Berlin in 1901.

Doris M. Cochran became aid to Stejneger in 1919 and in the ensuing years was promoted through the grades to associate curator in charge, Reptiles and Batrachians, in March 1943. In addition to a number of shorter articles, she is the author of "The herpetology of Hispaniola" (1941).

Fishes

After having shown marked aptitude for scientific work as a student and as assistant of Louis Agassiz, in the fall of 1850 Charles Girard began his association with the Smithsonian, where for 10 years he was Baird's principal assistant, preparing reports on the cold-blooded vertebrates received from government sources. Girard was the author of 42 papers on fishes, including a study of North American minnows (Cyprinidae) and a monograph of the sculpins (cottoids), and was accorded high rank among the descriptive zoologists of that period.

Through Baird's influence, Theodore Nicholas Gill was included in 1859 in the group who were being paid for the preparation of zoological reports for the Northwestern Boundary Survey, and the following year he was working on the fish report for the North Pacific Exploring Expedition. Gill became a member of the Smithsonian staff in 1861. Between 1865 and 1874 he was in charge of the Smithsonian library deposited in the Library of Congress. For almost 40 years after 1874 Gill was a volunteer worker in the Institution. As an analytical taxonomist, he possessed an unrivaled knowledge of the scientific literature, and his scholarly treatises on fishes reveal a keener understanding of the significance of structure in classification than that shown by most of his contemporaries. Gill published 388 papers on fishes, of which the most outstanding contribution was the arrangement of the families and the diagnostic analyses of the genera included in certain families. His papers on parental care and other phases of the natural history of fishes were particularly noteworthy.

Having spent two summers on the coast of New Jersey and subsequent seasons at Woods Hole, Massachusetts, and Eastport, Maine, Baird was so impressed with the importance of a thorough investigation of the factors responsible for the decrease of food fishes along the North American coasts that he assisted a senatorial friend in drafting a bill for such an inquiry. This resulted in the creation by Congress of the U. S. Fish Commission in 1871, and Assistant Secretary Baird was appointed to serve without salary as commissioner.

George Brown Goode was brought by Baird to Washington in 1877, and was given increasing responsibilities in the direction of the National Museum and the Fish Commission, both of which were outgrowths of activities fostered by the Smithsonian. His interest in the economic aspects of ichthyology led to the publication of the natural and economic history of the American menhaden (1879).

Another able investigator, Tarleton Hoffman Bean, came to the National Museum from Pennsylvania as Goode's colleague and held the position of curator of Fishes from 1880 to 1895. He became a leading authority on American fresh-water fishes and with G. Brown Goode published "Oceanic ichthyology" in 1895. In addition to his noteworthy taxonomic studies, Bean also became the most distinguished fish culturist in America. His brother, Barton A. Bean, was in charge of the fish collection from 1895 to 1932 and published a number of articles on deep-sea and fresh-water fishes. B. A. Bean's successor, George S. Myers, remained with the National Museum from 1933 to 1936 and in that interval described some remarkable deep-sea fishes, oviparous cyprinodonts, and Asiatic and South American fishes. The present curator of Fishes, Leonard P. Schultz, took charge of the Division in 1936, and since then his main contributions have been studies on the fishes of Phoenix and Samoan Islands and the fresh-water fishes of Venezuela.

The fish collection of the National Museum has constituted the basis for a large number of technical revisions and monographs by David Starr Jordan and his associates, including Alembert W. Brayton, John O. Snyder, Edwin C. Starks, Henry W. Fowler, Barton W. Evermann, Charles H. Gilbert, Joseph Swain, Seth E. Meek, and Carl H. Eigenmann, as well as by S. F. Hildebrand and other members of the Fish and Wildlife Service.

Hugh M. Smith, formerly U. S. Commissioner of Fisheries (1913–22), adviser in fisheries to the Siamese Gov-

ernment (1923–35), and after 1922 associate in zoology in the National Museum, prepared before his death in 1941 "The fresh-water fishes of Siam, or Thailand" (1945).

Insects

From most of the government expeditions the Smithsonian received large quantities of zoological specimens, sometimes more than could be handled readily by the staff, and consequently some provision had to be made for the storage and preservation of such materials. Thus, in accordance with the original plan adopted for fostering scientific research both at home and abroad, most of the insects were forwarded to prominent entomologists, the orders being distributed as follows: Coleoptera to John Lawrence LeConte, George Henry Horn, and Henry Ulke; Hemiptera to Philip Reese Uhler; Orthoptera to Samuel H. Scudder and Cyrus Thomas; Lepidoptera to William Henry Edwards, John Goodlove Morris, James Brackenridge Clemens, and Richard Harper Stretch; Hymenoptera to Henri de Saussure, of Geneva, Switzerland, Edward Norton, and Ezra Townsend Cresson, Sr.; Diptera to Hermann Loew, of Vienna, and Baron Carl Robert Osten Sacken, a Russian diplomat; and Neuroptera to Hermann August Hagen. The records also show that among other arthropods the myriapods were distributed to Horatio Charles Wood and the spiders to James Henry Emerton. According to the Annual Report of the Smithsonian for 1868, "all of the specimens of insects which have been collected by the institution have been divided among collaborators for study and arrangement, to be reclaimed at any time when required by the institution."

In the interval between its founding and 1868, the Institution thus materially aided the study of entomology, not only by making collections in that branch of zoology available to qualified investigators but also by arranging for the preparation and subsequent publication of a series of memoirs in which would be recorded the state of knowledge at that time. In 1865, however, it was announced that the insects received had been placed as usual in charge of the Entomological Society of Philadelphia, and this policy seems to have been continued until about 1874, when it was decided to make the Department of Agriculture the repository. Nevertheless, at least one collection of insects in 1868 was turned over to Townend Glover, who had received in the winter of 1853–54 an appointment in the Bureau of Agriculture of the Patent Office to collect "statistics and other information on seeds, fruits and insects."

Following the retirement of Glover in 1878, Charles Valentine Riley was appointed entomologist to the U. S. Department of Agriculture. The present entomological collection does not date from much earlier than 1881, when Riley deposited his collection in the National Museum and was designated honorary curator of Insects. When, in 1886, the Museum appointed John D. Smith as assistant curator of Insects, Riley formally transferred the entire insect collection, then numbering 115,000 specimens. Riley retired in 1894 with the intention of devoting the rest of his life to research, but was killed in September 1895.

With the appointment of L. O. Howard in 1895 as successor to Riley in the Department of Agriculture, and as honorary curator of Insects in the National Museum, several of his economic staff were designated as custodians. Among them were D. W. Coquillett for Diptera, William H. Ashmead for Hymenoptera, E. A. Schwarz for Coleoptera, Harrison G. Dyar for Lepidoptera, and Nathan Banks for Arachnida. These men and their successors were recognized as authorities for the groups under their charge, and while they were expected to perform their official duties of identifying insects for the Department they were also charged with the responsibility of classifying, improving, and increasing the reference collections.

John B. Smith held the position of assistant curator of Insects for approximately three years and subsequently, following his acceptance of the office of state entomologist of New Jersey, attained considerable prominence as an economic entomologist. Although no assistant curator was appointed for eight or nine years after Smith's departure, Martin L. Linell, an aid, took care of the collection until his death in 1896. Linell's reputation as an entomologist rests chiefly on his report on the beetles of the Galápagos Islands.

As stated previously, William H. Ashmead was detailed by Howard in 1895 with the concurrence of the administrative officials of the National Museum to be custodian of the Hymenoptera. On 1 July 1897, however, he was transferred to the position of assistant curator, Division of Insects, and continued in the employ of the Museum until April 1908. Especially noteworthy as regards originality and general usefulness were his memoirs, "Classification of the ichneumon flies" (1900) and "Classification of the chalcid flies" (1904). Ashmead's studies on the parasitic Hymenoptera constitute the basis for all similar work of recent years.

James C. Crawford succeeded Ashmead as assistant curator of Insects in May 1908 and was promoted to associate curator in 1911. Until March 1919, when he transferred to the U. S. Department of Agriculture, Crawford was chiefly occupied with the reorganization of the insect collection and was responsible for the installment of a unit system for the storage of specimens, the greatest single contribution to the preservation of the collection.

John M. Aldrich, honorary custodian of Diptera since December 1918, was appointed associate curator, Division of Insects, on 4 April 1919 and advanced to curator on 1 July 1928. Two publications, "Catalogue of North American Diptera or two-winged flies" (1904) and "Sarcophaga and its allies in North America" (1916), on which Aldrich's reputation as an entomologist mainly rest, were printed before he came into association with the Museum. Subsequently, after visiting European museums, Aldrich became interested in determining the true identity of early described species of muscoid flies.

Following the death of Aldrich on 27 May 1934, the vacancy in the Division of Insects was filled on 1 July

1934 by transfer of Edward A. Chapin from the Bureau of Animal Industry. Chapin has written generic revisions of the clerids, scarabaeids, and coccinellids. Richard E. Blackwelder, the present associate curator, came to the Division as assistant curator during July 1940. Previously, as the recipient of the Walter Rathbone Bacon Traveling Scholarship, Blackwelder was enabled to visit certain Caribbean Islands and to collect the necessary materials for his "Monograph of the West Indian beetles of the family Staphylinidae" (1943).

Marine Invertebrates

William Stimpson, a student of Louis Agassiz and naturalist for the North Pacific Exploring Expedition commanded by Commodore Ringgold and Captain Rodgers, on his return in 1856 began the preparation of his report at the Smithsonian Institution. Stimpson seems to have been, nominally at least, in charge of the collection of invertebrates in the Institution until 1865, when he was appointed curator and secretary of the Chicago Academy of Sciences. When Stimpson died in 1872, he left an enviable reputation for his work on the invertebrates. The collections made by him while he was attached to the North Pacific Exploring Expedition, as well as more than 10,000 jars of the Smithsonian collection of Crustacea, then the largest of its kind in the world and including many of James D. Dana's types from the U. S. Exploring Expedition (Wilkes, 1838–42), were totally destroyed in the Chicago Academy of Sciences by the disastrous fire of 8–11 October 1871.

In addition to the invertebrates received from these earlier expeditions, numerous investigations of the seas and fresh waters conducted from vessels belonging to the U. S. Fish Commission as well as from others under private auspices brought together a large amount of material for the study of the lower forms of aquatic life. Prior to 1880 funds at the disposal of the Institution were not adequate for the employment of someone to assume direct care of the invertebrate collections. It is therefore fortunate that these collections were examined from time to time by competent naturalists searching for materials to further their own studies, and in this manner their safety was assured. W. H. Dall, who had a special interest in mollusks, had paid attention to the care and preservation of other groups of marine invertebrates and in recognition of these voluntary services had been designated curator of Marine and Aquatic Invertebrates in 1879.

Richard Rathbun was appointed in 1878 scientific assistant to the U. S. Fish Commission, whose collections were then in New Haven, Connecticut. In 1880 Rathbun was transferred from New Haven to Washington, where he subsequently became curator of Marine Invertebrates in the National Museum, a position he held until 1914, although he was made assistant secretary in charge of the National Museum in July 1898. Rathbun specialized on the economic aspects of marine biology, and his report on the natural history of the crustaceans, worms, radiates, and sponges is recognized as a work of highest value. One of the most important contributions to marine economic zoology is his survey of ocean temperatures. The copepods collected and identified by Rathbun formed the basis for the report on the Woods Hole region by Charles B. Wilson in 1932. Rathbun's contributions to our knowledge of the echinoids and parasitic copepods are equally well known.

Prior to his appointment on 13 January 1890 as assistant curator in the Division of Marine Invertebrates, James E. Benedict had been naturalist on the U. S. Fisheries steamer *Albatross*. The most noteworthy publications of Benedict until 1909, when he was placed in charge of the Museum exhibits, were those relating to the hermit crabs, king and rock crabs, and the small lobsterlike crustaceans of the family Galatheidae.

Mary Jane Rathbun, a sister of Richard Rathbun, received world-wide recognition for her research on recent and fossil decapod crustaceans. Her monographs on the grapsoid, spider, cancroid, oxystomatous, and allied crabs of America and the fresh-water crabs of the world in particular are recognized as outstanding contributions. She came to the National Museum in 1886 and resigned in 1914 but continued her association with the Institution as honorary associate in zoology until her death in 1943.

Her successor, Waldo La Salle Schmitt, became curator of the Division of Marine Invertebrates in 1920 and a specialist in carcinological research, publishing accounts of the decapod crustaceans of California, nonbrachyuran decapods of the American Museum Congo Expedition, the penaeid shrimps collected by the F.I.S. *Endeavour* in Australian seas, the mantis shrimps (stomatopods) of the West Coast, and the fresh-water *Aegla* of South America.

From 1900 until his retirement as associate curator in March 1944, Clarence R. Shoemaker was engaged in revisionary studies on the amphipods, the results of which were published in various publications. Special mention is made of his reports on the amphipods of the Canadian Arctic, Hudson and James Bay, and Bermuda.

With the limited funds at its disposal, the Institution has never been in a position to employ enough specialists for the furtherance of research on all the phyla in the animal kingdom, but has had to rely on the interested cooperation of specialists in other institutions for the preparation of reports as well as for the identification of such materials. Some of the most distinguished zoologists in North America between 1870 and the present time have based memoirs largely on invertebrate materials in the National Museum.

Over the years, first James M. Flint and later Joseph A. Cushman have materially benefited the collection by the identification of the Foraminifera. The Institution has published a number of Cushman's comprehensive memoirs, notably "A monograph of the Foraminifera of the North Pacific Ocean" (1910–17) and "The Foraminifera of the Atlantic Ocean" (1918–31). The opalinid protozoans, salps, and pyrosomas were described by Maynard M. Metcalf.

The sponges have been studied by Alpheus Hyatt, Edward Potts, H. V. Wilson, and M. W. De Laubenfels.

For many years Charles Cleveland Nutting was the chief cooperating specialist on the hydroids, and afterward assistance was given by C. McLean Fraser. Many of the jellyfish were included in the publisned works of Alfred G. Mayer. The siphonophores obtained on the cruises of the *Albatross* were reported on by Henry B. Bigelow. Studies by Addison Emory Verrill on the coelenterates while employed by the U. S. Fish Commission constitute one of his chief contributions to invertebrate zoology. Oscar Carlgren was the author of several papers on the anemones, and Walter K. Fisher revised the hydrocorals. The nemerteans have been the subject of special studies by Wesley R. Coe. From 1914 to 1929, Harry K. Harring, custodian of the Trochelminthes, in collaboration with Frank J. Meyers, advanced our knowledge of this phylum.

Since 1912, Raymond C. Osburn has assisted with the identification of the bryozoans (Molluscoidea). Frank Smith and Gordon E. Gates devoted most of their lives to studying earthworms. Among the authorities who have contributed to our knowledge of the marine annelid worms (polychaets) are James E. Benedict, A. L. Treadwell, and Olga Hartman. The gephyreans were at one time identified by Henry B. Ward and R. V. Chamberlin; the most detailed report, however, was published by John Hiram Gerould. A comprehensive study of the echiuroid worms was recently completed and published by Walter K. Fisher. Many of the leeches were submitted to J. Percy Moore for identification. Several specialists, including Edmund B. Wilson, Leon J. Cole, Wm. Allen Hilton, and Joel Hedgpeth, have studied the sea spiders (Pycnogonida). Another recognized authority, Henry A. Pilsbry, has identified the barnacles (Cirripedia), although H. Boschma did some work on the rhizocephalans.

Reference should also be made to the work of Chancey Juday with the Cladocera. Of special interest and importance is the work of Charles Dwight Marsh with the fresh-water copepods. Reports on the collections of mysid shrimps have been prepared by Wm. M. Tattersall. Harriet Richardson, later Mrs. Searle, a voluntary collaborator since September 1896, is best known for her studies on the isopods and especially for her "Monograph of the isopods of North America" (1905). Indispensable contributions to the classification of the euphausid shrimps were made by H. J. Hansen. As regards the crayfish, Walter Faxon and W. P. Hay were the chief collaborators, and Robert Payne Bigelow was the author of fundamental studies on the stomatopods.

The ascidians or sea squirts (Urochorda) were reported on in part by William E. Ritter and by A. G. Huntsman and more fully by Willard G. Van Name. These specialists and many others not mentioned by name have assisted the Institution in carrying out its original plan for the preparation and publication of manuals of natural history.

Mollusks

The early history of the Division of Mollusks was much the same as some of the others, with quantities of shells pouring into the Smithsonian from the exploring expeditions and apparently with no one evincing a special interest in such specimens. It was not until 10 years after the founding of the Institution that any mention was made of efforts being made to further research on mollusks.

Augustus Addison Gould, of whom it has been stated that no one with the possible exception of Thomas Say had exercised a greater influence in developing the study of mollusks in this country, after the publication in 1852 of his report on the Mollusca brought back by the U. S. Exploring Expedition (Wilkes, 1838–42), gave his services to the Smithsonian Institution during the years 1858–60 and at intervals thereafter until his death in 1864.

During the winter of 1859–60, Philip Pearsall Carpenter, a British clergyman residing at Warrington, England, having been requested by the British Association for the Advancement of Science to prepare a report on the Mollusca of the Northwest Coast of America, visited Washington. At that time he volunteered to identify the collection of the Smithsonian. Since the task proved to be too extensive to be completed during the year, Secretary Henry made arrangements to ship the entire collection to England, where Carpenter devoted four years to the comparison of these mollusks with named forms in Hugh Cuming's collection, which in 1866 was purchased by the British Museum (Natural History). Carpenter contributed these services gratuitously in order that American students might have the benefit of such named specimens. Some of these old printed labels, which bear the inscription, "Named by Hugh Cuming, Esq., for the Smithsonian Institution, Washington, D. C.," are still associated with shells in the National Museum collection.

Voluntary assistance in the identification of mollusks was given also by Isaac Lea and Edward Foreman on the fresh-water clams, by Lea and George W. Tryon on fresh-water snails, by William Greene Binney on land shells, by Temple Prime on Sphaeriidae and Corbiculidae, by William Stimpson on Atlantic Coast mollusks, and by Thomas Bland on South American mollusks.

William Healey Dall, one of America's foremost malacologists, came under the influence of S. F. Baird when he arrived in Washington in 1865 to secure special training for his duties as a member of the scientific staff of the Russian-American Telegraph Company's North Pacific Exploring Expedition. Returning to Washington in 1868, Dall was assigned a room in a tower of the Smithsonian Building, where he worked on his collections and on the preparation of "Alaska and its resources," which was published in 1870. From 1871 to 1874, Dall was in charge of reconnaissance surveys of Alaskan coastal waters for the Coast Survey but found time to continue his malacological studies. He returned to Washington in 1875 and prepared the invertebrate catalogue for the International Exhibition of 1876. Dall was transferred in 1884 from the Coast and Geodetic Survey to the Geological Survey and as paleontologist was detailed to the National Museum, where he continued his research as honorary curator of the Division of Mol

lusks and Tertiary Fossils until his death in 1927. Dall was the author of more than 1,600 papers, among which were many outstanding contributions to malacology, including his studies on Pacific Coast marine shells, Florida Tertiary mollusks, the brachiopods, and his general classification of the pelecypods.

Paul Bartsch, who had been appointed aid in the Division of Mollusks in 1896, became curator of Marine Invertebrates on the death of Rathbun in 1914, and at the time of his retirement in 1946 was curator of the Division of Mollusks. During his association with the National Museum, Bartsch was the author of a large number of technical reports of which those dealing with the Philippine land shells, the teredos (shipworms), the pyramidellid mollusks, and the West Indian land shells deserve special mention.

Papers on almost every group of mollusks were published by Robert E. C. Stearns, associate in zoology, between 1866 and 1908. Besides the well-prepared synopsis of the pearly fresh-water mussels (1900), Charles T. Simpson, a divisional aid from 14 December 1889 to 31 December 1902, attracted well-deserved notice for his popular accounts of the natural history of lower Florida. The pearly fresh-water mollusks were also the chief interest of William B. Marshall, first employed as aid on 1 April 1895 and subsequently as assistant curator from 1914 to 1934. Other fresh-water mollusks as well as land shells were reported on by Marshall.

Harald Alfred Rehder has been a member of the staff since 1932 and succeeded Bartsch as acting curator on 1 May 1946. The major research of Rehder during this period appears in "New marine mollusks from the Antillean region" (1943) and, in joint authorship with Dall and Bartsch, in "A manual of the Recent and fossil marine pelecypod mollusks of the Hawaiian Islands" (1938).

The care and preservation of the coral collection form also one of the responsibilities of the Division of Mollusks. When Rathbun took charge of the invertebrates in 1880, the stony corals (Actinozoa) were said to comprise not only a collection of great value and beauty, but also the largest then existing in the number of kinds represented. Important additions to our knowledge of the corals were made by Addison Emory Verrill in the interval between 1871 and 1887, when he was in charge of scientific work in southern New England for the U. S. Fish Commission and prior to the physical transfer of those collections to the National Museum. These corals have also been reported on by others, including J. Playfair McMurrich and Alfred Goldsborough Mayer. Nearly 50 years have elapsed since T. Wayland Vaughan, the dean of coral specialists and custodian of Madreporaria, commenced his studies.

Partly for administrative purposes and partly because of the personal interest of the former curator, Paul Bartsch, the parasitic helminth worms were allocated to the Division of Mollusks. Charles Wardell Stiles served as custodian of the helminths from 1894 until 1931, and more recently the parasitic forms have been referred to Benjamin Schwartz and Emmett W. Price, of the Bureau of Animal Industry.

Echinoderms

Although the Division of Echinoderms is a comparatively recent offshoot of the Division of Marine Invertebrates, a limited amount of research work on this phylum had been sponsored much earlier by the Institution. The starfishes, sea urchins, crinoids, and other echinoderms received from the North Pacific Exploring Expedition were placed in the hands of J. M. Barnard in 1858 for study and description, but unforeseen circumstances prevented the publication of the reports of this expedition. Subsequently, in 1861, both William Stimpson and Louis Agassiz examined all the echinoderms stored in the Smithsonian.

Theodore Lyman, another student of Louis Agassiz, began publication of papers on the brittlestars belonging to the Smithsonian collection in 1858, and during the ensuing years additional material was transmitted to him for study. In the period between 1882 and 1891, Lyman was studying the Astrophytons. Addison E. Verrill reported on the echinoderms secured by the U. S. Fish Commission on the northeast coast of North America and on a collection received from Kerguelen Island. His assistant, Katharine J. Bush, prepared the catalogue for the echinoderms dredged along the coast of Labrador. The sea cucumbers (Holothuroidea) were studied by Hubert Ludwig, Hubert L. Clark, and Charles L. Edwards. Arrangements were made in the interval between 1882 and 1891 with Alexander Agassiz for studies on the sea urchins (Echinoidea).

Austin Hobart Clark, who had been acting chief of the scientific staff of the steamer *Albatross* during 1906–07, became associated with the National Museum in 1908 as collaborator in marine invertebrates. When the Division of Echinoderms was established in 1920, Clark was appointed curator. Since then he has specialized on crinoids and has also given some consideration to problems related to oceanography and marine biology. The results of Clark's investigation on the echinoderms are recorded in numerous shorter articles as well as in "A monograph of the existing crinoids" (1915–41).

Special mention should be made of the many monographs and shorter articles on the starfishes and their kin by Walter K. Fisher and, in particular, "Asteroidea of the North Pacific and adjacent waters" (1911–30) and the "Starfishes of the Philippine seas and adjacent waters" (1919).

Comparative Anatomy

Frederick A. Lucas had charge of the Division of Comparative Anatomy from 1881 until 1904, first as assistant curator and subsequently in 1898 as curator. During these years all the vertebrate skeletal materials now in the care of the respective divisions were under his supervision. Lucas was chiefly responsible for the large and well-organized comparative anatomy exhibit in the National Museum. His investigations dealt mainly

with the osteology of the vertebrates and among his publications of this period mention should be made of "The expedition to the Funk Island with observations upon the history and anatomy of the great auk" (1890) and "On the structure of the tongue in hummingbirds" (1891).

Plants

For the first decade at least in the existence of the Smithsonian Institution, some of the officers in charge of various government expeditions apparently received no definite instructions regarding the disposition of plant materials. Consequently, a considerable portion of the botanical collections made by the United States and Mexican Boundary Survey, the military reconnaissance expeditions, and the Pacific Railway Surveys were shipped directly to John Torrey, who held the post of professor of chemistry at Princeton University from 1830 to 1854 and after 1856 became professor of botany and chemistry at Columbia University. In the identification of these materials, Torrey obtained the cooperation of such specialists as Asa Gray, William S. Sullivant for the mosses and liverworts, Edward Tuckerman and M. A. Curtis for the lichens, George Engelmann for the Cactaceae, and George Thurber for the grasses.

Other plant collections brought back by government scientific or exploring expeditions, travelers, and collectors or received from other sources accumulated in the Smithsonian Institution. About 1860, Prof. Torrey wrote Secretary Henry that he was willing to supervise the selection and preparation, without compensation for his personal services, of a single series of specimens from all the botanical collections made by the various government exploring expeditions as well as from the plant materials then stored in the Institution. This disinterested offer of collaboration by Torrey resulted in the arrangement of a fairly complete set of some 15,000 to 20,000 specimens for the National Herbarium, as well as several duplicate sets for presentation to the principal American and European museums, and the remainder for distribution to colleges and private herbaria. When he reached the age of 70 years, Torrey found it necessary in 1868 to make arrangements for the return of this collection of plants to the Smithsonian, and because of the inadequate appropriations for the maintenance of the museum the National Herbarium was transferred the same year to the Department of Agriculture.

Charles Christopher Parry, who had spent the winter of 1852–53 in Washington preparing his report as botanist to the United States and Mexican Boundary Survey, in 1869 was appointed botanist to the Department of Agriculture, a position he held for three years. This appointment was terminated in 1871 because the then U. S. Commissioner of Agriculture held the opinion that "the routine operations of a mere herbarium botanist are practically unimportant." It is generally conceded that the identification and care of the plant collections which were being received by the national repository required considerable technical ability.

On 1 April 1872, George Vasey was appointed botanist of the Department of Agriculture and placed in charge of the National Herbarium. The task of organizing the collection of plants that had accumulated from exploring voyages and transcontinental railroad surveys under government auspices was a difficult undertaking but one that Vasey carried through with unusual success. Vasey became a distinguished specialist on grasses and was honorary curator of the Department of Botany in the National Museum until his death in 1893.

Frederick Vernon Coville in 1893 succeeded Vasey as botanist and curator of the National Herbarium, which remained in the custody of the Department of Agriculture until 1896, and at the same time became honorary curator of the Division of Plants in the National Museum, a post he held until his death in 1937. Coville was best known for his observations on ecological plant geography in "Botany of the Death Valley Expedition," for his taxonomic studies on the rushes (Juncaceae) and on our native currants and gooseberries (Grossulariaceae), and for his experimental studies relating to the improvement of strains of blueberries, particularly the effect of soil acidity and the stimulating role of cold.

When the National Herbarium was returned to the National Museum in 1896, Joseph Nelson Rose was transferred from the Department of Agriculture. He is best known for his studies on cacti and Crassulariaceae, which from 1912 to 1923 were carried on while on furlough from the National Museum under the auspices of the Carnegie Institution of Washington.

William R. Maxon entered the employ of the National Museum on 10 July 1899 as aid and was promoted through the grades, becoming curator of Plants on 1 February 1937 and retiring on 31 May 1946. Many articles by Maxon on tropical American ferns in *Contributions from the United States National Herbarium* stand as an enduring monument to his industry.

The contributions to botany by Paul Carpenter Standley, formerly associate curator and a member of the staff from 1909 to 1928, are centered around systematic works dealing with Mexican and Central American plants. Especially noteworthy as regards general usefulness are his "Trees and shrubs of Mexico" (1920–26) and the "Flora of the Panama Canal Zone" (1927).

Ellsworth P. Killip, who has been with the National Museum since 7 July 1919, succeeded Maxon as curator on 1 June 1946. Aside from the recording of field observations and the collecting of plant materials in Colombia, Venezuela, Peru, and Brazil, Killip has published the "American species of Passifloraceae" (1938).

The general growth of the plant collection necessitated the employment of additional staff members. Emery C. Leonard joined the staff as aid on 2 January 1918 and was reallocated to assistant curator on 1 June 1928. He has specialized on the West Indian Acanthaceae and has begun an elaborate work on the flora of Hispaniola. Conrad V. Morton was appointed aid on 20 August 1928 and was promoted to assistant curator on 16 March 1939. He is a specialist on the Gesneriaceae of Mexico and Central America and also has made important con-

tributions to our knowledge of the potato family. Asiatic botany, particularly that of China, has been the special interest of Egbert H. Walker, who accepted an appointment as aid on 2 July 1928 and was advanced to assistant curator on 1 February 1942.

In conclusion, it should be emphasized that this article directs attention to only the most outstanding pieces of research that the Smithsonian has sponsored. It should be borne in mind also that the staff has always given a considerable portion of its time to helping others less advantageously situated by identifying materials, collating data, and furnishing literature. Such has always been the pervasive and far-reaching influence of Smithsonian activities. Its great collections representing the natural history of the earth belong to the American people, and it is right that they should use them to the utmost.

A Century of Smithsonian Publications

W. P. True
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From the very beginning, publications have constituted a major item in the Smithsonian Institution's program dedicated to the increase and diffusion of knowledge among men. It has used, and still uses, other methods of diffusing knowledge—among them, museum and art gallery exhibits, a world-wide correspondence on scientific matters, the International Exchange Service which it was instrumental in initiating, lectures, radio programs, and science news releases—but the foremost method has always been the printed word. Joseph Henry, first secretary of the Institution, saw clearly the great need at that time of more media for publication of scientific discoveries, and among his first acts as secretary was the establishment of a series of Smithsonian publications, *Contributions to Knowledge.* From this single initial series, the publications of the Institution have expanded with the growth of its research work until today 14 distinct series appear under the Smithsonian imprint, each series serving a particular function.

Prof. Henry felt so strongly the importance of diffusing knowledge more widely in the early days of the Institution that he wrote in 1852:

> The worth and importance of the Institution are not to be estimated by what it accumulates within the walls of its building, but by what it sends forth to the world. Its great mission is to facilitate the use of all the implements of research, and to diffuse the knowledge which this use may develop.

Probably the best-known publications of the Institution proper are its *Annual Reports.* Each year the General Appendix contains a carefully selected group of 20–25 articles presenting as far as possible in nontechnical language the progress and important developments in nearly all branches of science. The Smithsonian Reports find a wide field of usefulness among teachers, students, and the general public, and they have doubtless had a not inconsiderable part in building up the present widespread appreciation of the value of science. All members of the Institution's scientific staff aid in selecting articles for the Annual Report, and a large number of journals dealing with scientific subjects are examined each year in order that no major development may be overlooked. A complete set of Smithsonian Reports constitutes in effect a history of 100 years of progress in science.

The other two series published by the Institution proper—*Smithsonian Contributions to Knowledge* and *Smithsonian Miscellaneous Collections*—are technical in character and contain the results of research in many fields of science by members of the Institution's staff and by collaborators and outside scientists. The Contributions series was established soon after the founding of the Institution, the first monograph to appear being Squier and Davis' "Ancient monuments of the Mississippi Valley," published in 1848. The Contributions soon became widely known among scholars, and numerous important monographs appeared in the series in ensuing years. The only requirement was that each paper should constitute a positive addition to knowledge based on original research. A few of the well-known papers in this series are: "Memoir on mechanical flight," by Langley and Manly; Coffin's "The winds of the globe"; Shaler's "Comparison of earth and moon"; and Morely's "On the densities of oxygen and hydrogen, and the ratio of their atomic weights." The Contributions appeared in quarto form, and because of the greater cost of printing in that form, the series was discontinued in 1916.

The Miscellaneous Collections, started a few years after the Contributions, contained, as long as the latter series existed, shorter papers in all branches of science, although mainly anthropology, biology, geology, and astrophysics. Since 1916, however, the Miscellaneous Collections has included practically all the scientific material published by the Institution, except the semipopular papers appearing in the Annual Report. Some of the better-known works in this series are the Smithsonian Physical Tables and the Smithsonian Meteorological Tables, the World Weather Records, Secretary Wetmore's "A systematic classification for the birds of the world," Hrdlička's "The skeletal remains of early man," Walcott's several volumes on Cambrian Geology and Paleontology, and Abbot's papers on solar radiation studies. The Miscellaneous Collections is now in its 106th volume.

Out of the early activities of the Institution there developed a number of bureaus which were later recognized as public necessities and received governmental support. To provide outlets for the work of these bureaus other series of publications were established, the earliest

among them being the *Proceedings* and *Bulletins of the U. S. National Museum,* and the *Reports* and *Bulletins of the Bureau of American Ethnology.*

A chief function of the scientific staff of the National Museum is to conduct original researches on the great national collections in anthropolgy, biology, geology, and engineering, and the results of these studies appear in the Bulletins and Proceedings. The Bulletins are reserved for the larger monographic works in these fields, whereas the Proceedings series provides for the publication of shorter papers, a considerable proportion of them devoted to the description of new species of mammals, birds, fishes, insects, mollusks, and other life forms discovered in the course of investigations by the staff. Up to 10 August 1946, 192 Bulletins have been issued, and 96 volumes of Proceedings, comprising 3,199 individual papers. Issued as a part of the Bulletin series are the *Contributions from the National Herbarium,* in which are published botanical papers by members of the Museum staff and other scientists working on the plant collections of the National Herbarium. The Bulletin series contains such works as Bent's Life Histories of North American Birds, Clark's Monograph of the Existing Crinoids, Rathbun's volumes on American Crabs, the volumes on scientific results of the *Albatross* Philippine Expedition, Perry's "Metallography of meteoric iron," and Standley's "Trees and shrubs of Mexico."

The Reports and Bulletins of the Bureau of American Ethnology deal with all phases of the study of the American Indians. Up to and including 1933 the Reports were issued in quarto form and contained scientific monographs in addition to the administrative reports. Thereafter only administrative reports in pamphlet form were issued, all the scientific material appearing as Bureau Bulletins in octavo size. Forty-eight of the quarto Reports were published, and 143 Bulletins have appeared. Among the more comprehensive of the Bureau publications may be mentioned the *Handbook of American Indians,* edited by Hodge; Kroeber's *Handbook of the Indians of California;* Swanton's *The Indians of the southeastern United States;* and the five-volume *Handbook of South American Indians,* edited by Steward, of which the first two volumes have just appeared.

Other series bearing the Smithsonian imprint, the titles of which indicate the content, are the *Annals of the Astrophysical Observatory, Oriental Studies* and *Occasional Papers of the Freer Gallery of Art, Catalogs of the National Collection of Fine Arts, Publications of the Institute of Social Anthropology,* and *Smithsonian Special Publications.*

In the hundred years of its existence, the Institution has put out some 7,500 individual publications, varying in size from 1-page leaflets to 1,000-page monographs. Some 12,000,000 copies of these have gone out—for the most part free—to libraries, scientific and educational institutions, and interested individuals—mainly scientific workers and students. Only as scientific investigations are recorded in print and put in the hands of those who can use them are they of potential benefit to mankind. Nearly all Smithsonian publications have recorded the results of fundamental researches, which, pooled with like material published by other scientific organizations, form a reservoir of basic new knowledge available to workers in economic fields. It has been said that few encyclopedias and textbooks exist that have not drawn to some extent on Smithsonian publications. However that may be, the "diffusion of knowledge" desired by James Smithson has been increasingly fostered throughout the past 100 years by the publications of the Institution.

The International Exchange Service

H. W. Dorsey
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The Smithsonian International Exchange Service was started in 1849, and its operations have grown in scale from the few hundred packages of publications then handled annually to the 714,877 packages that passed through the Service in 1939, the last year before the beginning of World War II.

Two years after its establishment in 1846, the Smithsonian Institution issued the first of its long series of scientific publications. In addition to the American distribution, several hundred copies were sent the following year to scientific and other learned institutions abroad, in return for which many valuable publications were received from these institutions. To continue this desirable exchange of intelligence with the other nations of the earth, Joseph Henry appointed agents in a number of foreign countries. He then offered to other learned bodies the privilege of utilizing this Smithsonian exchange system, an offer that was promptly accepted.

Thus began a project that has grown steadily in scope and usefulness to the present day. By 1880 the cost of the exchange system to the Smithsonian became a very heavy burden, in spite of the generous granting of free ocean freight by many international steamship lines and the cooperation of our own and of foreign governments in admitting exchange shipments free of duty. Congress was appealed to for aid, and in 1881 a small appropriation was granted for the support of the system. This support has continued down to the present time, reaching approximately $50,000 a year just before World War II. War conditions naturally disrupt the international exchange of publications, although exchanges were continued throughout the war years with all countries of the Western Hemisphere and a few in other parts of the world.

From the beginning of the Smithsonian exchange system, U. S. Government departments made use of the service for exchange of their official documents for those of other governments. In 1867 Congress passed a law systematizing this governmental interchange, and in 1873 the first shipments were made by the Institution under the new law. A few years later international conferences began in Brussels to discuss the exchange between countries, not only of governmental documents, but also of

scientific and literary publications, and in 1886 a formal agreement was reached which was ratified by eight nations. Others adhered to the Brussels convention later, and with those countries that did not special arrangements were made for exchanges. The Smithsonian Institution was recognized as the official exchange agency of the United States.

Libraries, scientific societies, educational institutions, and individuals in this country who wish to distribute their publications abroad as gifts or exchanges send the separate addressed packages to the Smithsonian Institution, carriage cost paid. There they are sorted by countries and forwarded with similar shipments from other organizations to the exchange agencies in other parts of the world, where they are distributed to the addressees. Similarly, shipments of publications from exchange agencies abroad to this Institution are distributed free to addresses in this country.

The real contribution of the International Exchange Service lies in its promotion of the wide diffusion of scientific discoveries and of knowledge generally. It is often said that science knows no political boundaries, but without a general exchange of the published results of research, scientists would waste much time and effort in repeating work that had already been done elsewhere. Through the avoidance of such duplication of experimental work, progress in scientific achievement has been very greatly accelerated. The Exchange Service is a very tangible expression of the Smithsonian Institution's part in "the diffusion of knowledge" and also of the cooperative character of many of its activities.

The Library of the Smithsonian Institution

Leila F. Clark
Librarian, Smithsonian Institution

The library of the Smithsonian Institution, founded by the Act of Organization in 1846, with the initial purpose of procuring "a complete collection of the memoirs and transactions of learned societies throughout the world and an entire series of the most important scientific and literary periodicals," has been largely built up of publications received in exchange for the Institution's own publications. From the very beginning books and journals poured in, for the unique character of the new Institution itself and the quality of its first publications excited the interest of savants abroad as well as in America.

With this fine material in charge of the first librarian, Charles C. Jewett, a man of vision, tireless energy, and contagious enthusiasm far in advance of his time in library planning, the Institution was soon in possession of a well-organized and growing scientific library which was fast becoming a national reference and bibliographical center, for bibliography too was an early concern of the Institution. Not many years passed, however, before it became obvious that the increasing needs of the library for space and money, especially for carrying on certain of Mr. Jewett's plans for its future development, could not be met except by sacrificing too large a part of the funds and equipment needed to go on with the Institution's program for scientific research, and the regents decided that Mr. Jewett's program could not be supported further. But the library continued to grow, and its adequate housing and care presented serious problems. When a considerable amount of new space in the Capitol was made available to the Library of Congress, which at that time had about the same number of volumes as the Smithsonian library, the merging of the two libraries was proposed as offering advantages to both.

Consequently, upon recommendation of Secretary Henry, Congress in 1866 passed an Act authorizing the transfer of the library of the Smithsonian Institution to the custody of the Library of Congress, with special provisions not only for the continued freedom of its use by the Institution but also, through the secretary, for the same freedom of use of the Library of Congress as that enjoyed by members of Congress. Though the Act did not specifically require the deposit of later acquisitions, it was obviously important that the continuity of the sets of serial publications should be maintained, and in the years that have passed since the original Smithsonian Deposit of some 40,000 volumes was made, almost 1,000,000 volumes and parts have been added to it.

At the time of the transfer a small basic reference collection was retained at the Institution, while a messenger went daily to the Library of Congress to borrow whatever was needed for occasional use. As time went on, and the Institution initiated or was made responsible by the Government for more and more scientific and cultural enterprises, collections of books on the special subjects of its investigations began to be needed and were acquired, often more or less independently of each other.

In 1858, the Institution's Museum had become the authorized depository of the scientific collections of the Government, and after 1876, when there was a large influx of specimens from the Centennial Exposition in Philadelphia, it was officially designated as the U. S. National Museum. With the organization of its curatorial work begun, the Museum's need for a more adequate working library became acute. Museums, especially museums of natural history, both in this country and in Europe, had been undergoing transformation from what had been, in the main, cabinets of curiosities into scientific institutions. Scientific publication by museums was increasing enormously, and there was a corresponding rise in interest in museology as a subject for serious study.

So urgent was the need for more books that Secretary Spencer F. Baird in 1881 donated his own extensive private library, a valuable collection of standard works on biology and industry, to supplement the existing small nucleus of the Museum library. In response to a special circular many of the museums and scientific societies of Europe and America contributed sets of their publications, and new exchanges for the Museum's own publications were arranged. Second copies of many of the more

important series received by the Institution for the Smithsonian Deposit were also obtained by exchange, and other material was purchased.

Today the library of the National Museum numbers about 250,000 volumes, mostly on subjects with which the work of the curators is directly concerned—that is, the biological, geological, and anthropological sciences, the arts and industries, engineering, history and museology—and on many correlated subjects, especially scientific travels and geography. Of these books and periodicals, those devoted exclusively to special subjects, such as insects, plants, birds, graphic arts, and archeology, upon request of the curators concerned are assigned to sectional libraries in the various divisions of the Museum. These 31 sectional libraries vary in size according to the requirements of the division from fewer than 100 volumes to several thousand and are more or less fluid, in that volumes found to be no longer needed for immediate use in the division may be returned to the main library for filing.

The libraries of the other bureaus developed under the aegis of the Smithsonian Institution had origins similar to that of the Museum library—in the need for special working collections of books to be used as tools in aid of scientific research. The library of what is now the Bureau of American Ethnology had its beginning, coincidentally with that of the Bureau itself, in connection with the work of preparing for publication the archives, records, and materials relating to the Indians of North America that had been gathered by the geographical and geological survey of the Rocky Mountain region under Maj. John W. Powell. In 1879 Congress authorized the Smithsonian Institution to take over the direction of the work, and Secretary Henry appointed Maj. Powell to continue and complete it. For many years Maj. Powell had been director of the Geological Survey, and the Bureau of American Ethnology library was for some years housed in the Survey. Later the Bureau moved to rooms of its own on F Street and in 1909 was assigned to quarters in the Smithsonian Institution Building, where the library now occupies the east stack. This library is a carefully selected collection of about 40,000 volumes. Especially complete in source materials and other works dealing with the history, cultures, and linguistics of the North American Indians, it is now developing a similar collection on the Indians of South America. It includes also much material on the customs and languages of native peoples of other regions of the world.

Since its establishment in 1889 the National Zoological Park has assembled a small working library of about 4,000 volumes having to do especially with the taxonomy and distribution of wild animals and birds and with their care in captivity.

In 1890 was begun the formation of a special collection of books to serve the newly established Astrophysical Observatory in its studies of the constitution of the heavenly bodies and especially of the sun and its effects upon the earth. The Observatory library now has about 12,000 volumes on its shelves. In the Observatory's Division of Radiation and Organisms there is a small separate library of about 600 reference books and scientific journals, chiefly in the fields of botany, physics, and chemistry.

The library of what is now the National Collection of Fine Arts was until 1920 a small sectional library of the National Museum. In that year, the National Collection of Fine Arts, which was until 1937 officially named the National Gallery of Art, was made a separate administrative branch of the Smithsonian Institution, and the separate development of its library was begun around the nucleus of the books on fine arts withdrawn or transferred to it from the Museum library. It is now a growing art reference collection of 10,000 volumes, housed in rooms on the third floor of the Natural History Building.

The library of the Freer Gallery of Art had its origin in the small private collection of books on the art and culture of the East, a few of them in Chinese and Japanese, which Charles L. Freer had assembled and which came to the Institution as a part of his bequest. With the additions made to it since the opening of the Gallery in 1923, the library is now a fine reference collection of about 22,000 volumes, 6,350 of which are in Chinese and 780 in Japanese.

No coldly factual record of historic library dates and numbers of volumes can possibly give anything but an uncolored outline of the richly complex picture of books in use, and mention must be made of some of the persons whose business it was to acquire and make their use possible.

Charles E. Jewett, the first librarian, has long been one of the immortals of the library world, and it would be hard to overemphasize the important part he played in the early history of the Institution.

For many years after the termination of Mr. Jewett's services there seems to have been no one with the official title of librarian. The library was directly under the administrative charge either of the secretary or of the assistant secretary, and the work of receiving and recording accessions was assigned to clerical helpers, while some of the duties of librarian were performed by members of the scientific staff.

In the Institution's Annual Report for 1868 occurs the first mention of assistants in the library after the Smithsonian Deposit was made:

> Mr. Theodore Gill, who was formerly assistant in the library of the Institution, has been appointed one of the principal assistants in the national library, but he still continues his investigations in natural history at the Institution, and acts as the intermediate agent between the two establishments. Miss Jane Turner, who vindicates by her accuracy and efficiency the propriety of employing her sex in some of the departments of government, still continues to register the books as they are received through the extended system of international exchange.

The Annual Report for 1888 notes "the resignation of Miss J. A. Turner who had for many years performed the duties of librarian with the greatest diligence and faithfulness." The beautifully kept manuscript, "Turner records" of accessions, is still on file in the Institution.

Some of the library staff became almost legendary figures, and the 40-year service of Newton P. Scudder,

assistant librarian in the Museum, of encyclopedic memory, who, without benefit of subject cataloguing or recourse to a reference book, could produce upon demand the original description of a new species of insect, is still recalled with nostalgia by the older members of the present scientific staff.

John Murdoch was appointed librarian in 1887, and he served until 1891. Cyrus Adler, as librarian and later as assistant secretary in charge of the library, gave distinguished service to the Institution from 1892 until 1908. Paul Brockett was assistant librarian from 1902 until his resignation in 1924, and William L. Corbin, who was appointed librarian in 1924, served until his retirement in 1942.

The Smithsonian Deposit in the Library of Congress

Morris C. Leikind
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The Library of Congress is bound to the Smithsonian Institution with ties of the greatest intimacy. These ties are not merely the intangible ones of unity of purpose, i.e. "the increase and diffusion of knowledge among men." They are in fact visible and tangible bonds for all to see. Although the Library of Congress was already 46 years old when the Smithsonian Institution and its library were established, there began from the very moment of the birth of the younger institution a cooperation which has continued to this day to the mutual advantage of both and which has resulted in incalculable benefits to science and learning the world over.

The first systematic effort at cooperative cataloguing was proposed by the scholarly and imaginative librarian of the Smithsonian, Charles Coffin Jewett, and applied to the Library of Congress. As early as 1850 the Institution prepared a code of cataloguing rules together with a plan for stereotyping titles. Congress authorized the Institution to apply its rules and procedures to the collections of the Library of Congress, so that by 1854, 9,654 titles representing 21,805 volumes had been catalogued under this plan.

Under the old copyright laws the Smithsonian Institution was a co-depository with the Library of Congress for the receipt of copyrighted works. The Institution was instrumental in changing the copyright act so that the Library of Congress became the sole depository of such materials.

The final and firmest link in the bonds which united the two institutions was forged in 1866 when the library of the Smithsonian Institution was, by act of Congress, deposited in the Library of Congress. This action was necessitated by the growth of the Institution's library through its international exchange of publications to a size which it was unable to care for. Furthermore, this most valuable collection was endangered because it was not housed in a fireproof building. Thus, when commodious fireproof rooms were provided in the Capitol for the Library of Congress, the secretary of the Smithsonian Institution suggested that its books be transferred to the custody of the Library of Congress. In urging this action Joseph Henry wrote in 1865 as follows:

> The object of this transfer is not of course to separate this unique and highly prized collection of books from its relations to the Smithsonian Institution, for it must still bear its name and be subject to its control, but merely to deposit it where its preservation will be more certain and its usefulness more extended.

The act of transfer was approved by Congress on 5 April 1866. Of this transfer Prof. Henry later said:

> The union of the library of the Institution with that of the Congress still continues to be productive of important results. The Smithson fund is relieved by this arrangement from the maintenance of a separate library, while at the same time the Institution has not only the free use of its own books, but also those of the Library of Congress. On the other hand the collection of books owned by the Congress would not be worthy of the name of the National Library were it not for the Smithsonian deposit. The books which it receives from this source are eminently those which exhibit the progress of the world in civilization, and are emphatically those essential to the contemporaneous advance of our country to the higher science of the day.

True as these words of Joseph Henry were then, they are even more true today, for the 40,000 volumes of the original deposit have grown by a process of accretion and now number almost 1,000,000.

The publications deposited in the Library of Congress are received from all over the world by the Smithsonian Institution in exchange for its own publications or by gift. By far the largest and most important part of the Deposit is the collection of the proceedings and transactions of learned societies and institutions, and of other scientific and technical journals, which forms one of the most unique collections of such publications to be found anywhere in the world. Because of its size and importance this unit of the Smithsonian Deposit is familiary referred to as the "Deposit," but the Smithsonian Deposit also includes many thousands of other books, pamphlets, and manuscripts each marked with an identifying stamp but distributed and shelved throughout the Library according to classification. Notable among special collections that have been deposited by the Institution is the Langley Aeronautical Library of early aeronautical magazines, manuscripts, and other material which was transferred to the custody of the Library of Congress in 1930.

In 1897, when the Library of Congress occupied its new building, the importance of the "Deposit" was recognized by assigning it quarters on the northeast side of the second floor of the main building. In 1900 a special division of the Library of Congress, named the Smithsonian Division, was organized to care for the "Deposit" and for the distribution of all the current accessions received from the Institution. Francis Henry Parsons was assistant in charge of the Smithsonian Division from 1900 to 1925, and his diligent labors did much to develop the collection to its present state of eminence. In 1926 Frederick E. Brasch took over the duties of administering the Division. In the stacks adjacent were the main library collections of scientific works, and thus there

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was in being the physical basis for a Division of Science and Technology. Thus, with the tremendous advances in science during the past two decades the Smithsonian Deposit, with its unrivaled collections of the publications of learned societies, became more and more the center of scientific reference work in the Library of Congress.

In 1938, when the magnificent new annex to the Library was opened, the Smithsonian Division was moved to quarters in this building. The "Deposit" was shelved on Deck 12, in close proximity to the science collections, and its office occupied an alcove off the Thomas Jefferson Room, which houses the main reference collections in science, technology, medicine, and agriculture. Mr. Brasch, who administered the collection for 20 years, during his last year had the title of consultant in the history of science. He retired on 30 June 1946.

The Smithsonian Institution begins its second century at a time in world history when science has assumed an unprecedented importance in the affairs of men. The collections which the Smithsonian has amassed and continues to enlarge will thus play an increasingly significant role in the life of this Nation and of the world.

This Centennial Issue of *Science*, planned in midwinter, had to be shortened materially in view of the paper shortage. For that reason several book reviews of Smithsonian publications, which should have been included here, must be deferred to later issues.

Letters to the Editor

Botanical Taxonomy

With reference to C. R. Ball's complaints (*Science*, 1946, 103, 713), it may be said that an important reform is possible which does not involve any alteration of the rules. This is to omit the name of the author of the combination, when a specific name is transferred to a different genus from that to which it was referred by the original author. This is the general practice in zoology, and I have never known any inconvenience to arise. I, for one, propose to follow this method when referring to plants.

However, the real reason for the neglect of taxonomy is that it is too difficult and takes too much time. In order to revise a genus of plants it will usually be necessary to consult or borrow from many herbaria and to read and interpret literature in many languages, most of which is obtainable in only a few libraries. When all this is done, it still remains very desirable to have a knowledge of the living plants, wild and in the botanic garden. Sound taxonomy is the mother of sound ecology. We ask of a plant how it come to be and what are the conditions which now control its growth. We are involved in endless complexities, but it is possible to see and understand enough to answer many of our questions.

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Lightning-like Phenomena on the Moon

The following observations were made some time ago and seem to me to be worthy of recording in *Science*. During the evening of 17 June 1931, I was working in the yard near our house at Riverside, California, and happened to glance at the moon. It was an unusually fine, clearly outlined new moon, and as I stood looking at it, suddenly some flashes of light streaked across the dark surface but definitely within the limits of the moon's outline. Since this was a phenomenon which I had never seen before, I continued to watch it and saw similar flashes streak across the moon again in a moment or two. Without mentioning what I had seen, I called my wife's attention to the new moon. She admired it. When I asked her to watch it closely to see if she noticed anything strange, she said: "Oh, yes, I see lightning on the moon," adding that this appeared to be confined to the moon. We watched it for some 20 or 30 minutes during which the phenomenon must have occurred at least six or seven times. The facts were recorded in my notebook as of approximately 7:40 P.M., 17 June 1931. At the time, I was inclined to attribute the phenomenon to some sort of sunlight reflection from mountain peaks on the moon or possibly some sort of electrical activity. I wrote the Mount Wilson Observatory regarding the phenomenon, and the reply very courteously discounted my observations. The observations were carefully made and carefully verified, and at the time I assumed that the phenomenon was probably something with which astronomers were familiar.

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